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EXPERIMENTS ON THE ACTION OF FLAMELESS EXPLOSIVES UPON FIRE DAMP AND COAL DUST.

WE have been favored by the North of England Institute of Mining and Mechanical Engineers with a copy of the report of the proceedings of their flameless explosives committee.

The committee has just concluded a lengthy series of experiments, which were commenced as far back as March, 1892, with a view to determine the reliability of the various so-called safety explosives. The question is of vital interest to the miner; and the periodical occurrence of explosions for which no assignable cause is found suggests that many of the so-called flameless explosives which are in use are misnamed, and are therefore a constant peril to the miner. The results of this investigation prove that, contrary to the general opinion, there is not one of the commercial explosives that is flameless—that is to say, they are at any time liable to ignite explosive mixtures of gases and air, or of coal dust and air, or of all three.

The apparatus consisted of a long, wrought iron tube in which was placed the mixture of gas and air or the coal dust to be tested. The tube was open at one end, and at the other end was closed by a plate into which was fitted the end of a "cannon," from which the flameless explosive was fired, the flame, should there prove to be any, passing into the gases, etc., in the tube. The cannon was made capable of recoil upon being fired. Peep holes were provided at intervals of 10 feet, through which the effects of the explosion on the contents of the tube could be watched. In the cuts will also be noticed the fan by which the contents of the tube were agitated, together with the gasometer, piping, valves, etc., for charging the tube with the various gases and mixtures upon which the experiments were made.

The experiments were carried out with both stemmed and unstemmed shots. For the purpose of experiments with coal dust, six angle irons were riveted in pairs to the sides of the tube (Fig. 11). Brown paper frames (d, e and f, Fig. 12) were placed upon the angle irons and maintained in position by means of wooden pins forced through the frames into holes (spaced at intervals of 3 inches) made in the angle irons. Three frames were provided, numbered progressively 1, 2 and 3, commencing from the cannon; they were each 6 feet long and the width varied with that of the tube. The frames were fixed so as to intercept a line passing through the axis of the bore of the cannon.

The coal dust was placed upon one or all of these frames, or strewn along the bottom of the tube, if the experiment was to be made upon coal dust "in situ." If the experiment was made upon coal dust "in suspension," the fan was revolved for about 30 seconds before firing the shot.

The pit gas was obtained from a Northumberland colliery and contained 78 80 per cent. of combustible gas. The coal dust was obtained from the coal screens of the same colliery.

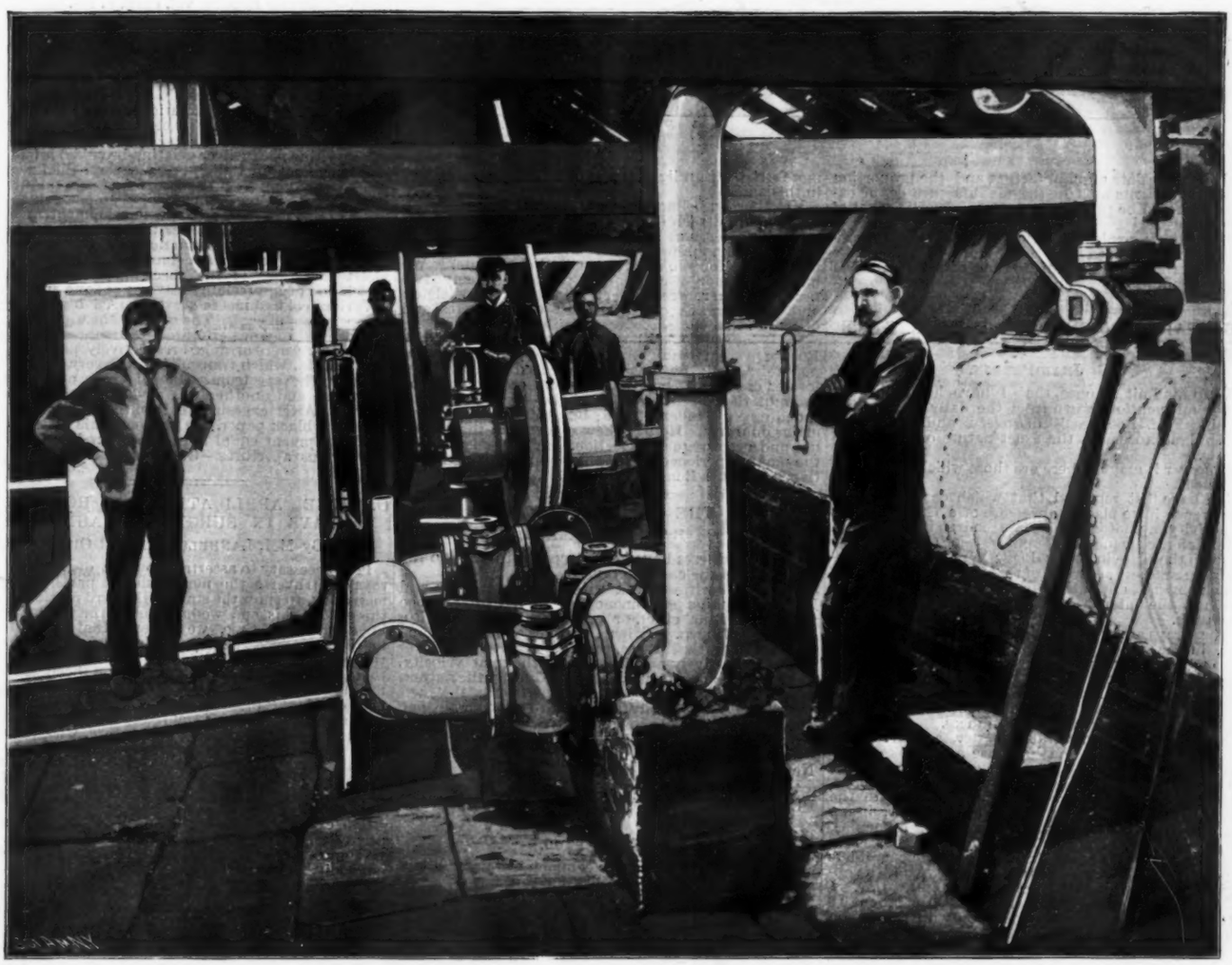
In summing up the results of its investigations, the committee says:

The results of the inquiry point very conclusively to the unreliability of all of the safety explosives; contrary to the general opinion at the time when these experiments were commenced, it is proved that no explosive is flameless, and that all are capable of igniting gaseous or coal dust mixtures.

Very interesting results have been obtained during the course of this inquiry. First, the sensitiveness to ignition of coal gas, as compared with pit gas, has been clearly demonstrated. Secondly, the presence of flames in an explosive gaseous mixture has been proved (the flames sometimes being first observed at points several feet remote from the cannon), without ignition of the gaseous mixture ensuing. The retarded ignitions of explosive mixtures of coal gas and the point of first ignition of gas mixtures occurring many feet distant from the cannon are interesting features in the inquiry.

Knowledge of this extensive subject—explosives—has only been obtained at the cost of much labor and expenditure from properly conducted experiments, and there still remains much to be done. Interesting results might be obtained by firing shots through a space containing atmospheric air into a chamber containing gas or coal dust mixtures. Many varieties of coal dust have not yet been tested, and little is known about the propagation of coal dust ignitions. By means of a constant current of air and coal dust, many interesting experiments might be made, and much useful knowledge gained.

All the safety explosives ignited mixtures of coal gas, and consequently the experiments are not included in the following epitome of results. The experiments with coal dust in situ are also excluded, as none of the safety explosives ignited such mixtures.



APPARATUS USED FOR TESTING FLAMELESS EXPLOSIVES.

Bellite.—No ignition occurred in the 45 experiments made in explosive mixtures of pit gas. There was one ignition in 7 experiments made in mixtures of pit gas and coal dust; and there was one ignition in 20 experiments in coal dust in suspension.

There are only two instances throughout the whole series of experiments (exclusive of those with coal gas) where a mixture was ignited by stemmed shots. These occurred with bellite and westfalit in explosive mixtures of pit gas and coal dust.

CONCLUSIONS.

The lengthy series of experiments, which have occupied the attention of the committee since March, 1892, appear to establish the following conclusions:

1.—The high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, securite, and westfalit) on detonation produce evident flame.

2.—The high explosives are liable to ignite either in-

flammable mixtures of air and fire damp—or air and coal dust—or air, fire damp, and coal dust, and therefore cannot be relied upon as insuring absolute safety when used in places where such mixtures are present.

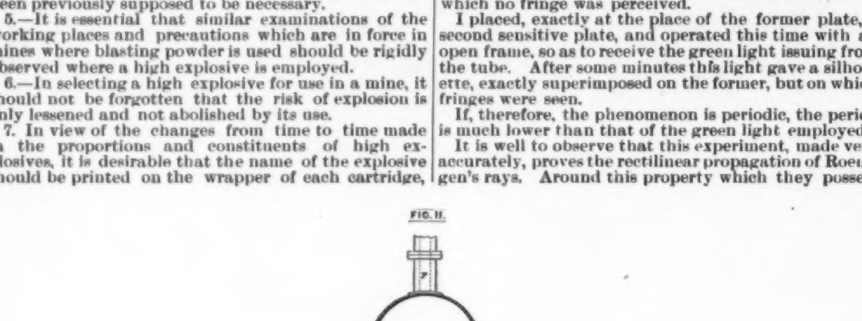
3.—The high explosives are less liable than blasting powder to ignite inflammable mixtures of air and fire damp—air and coal dust—and air, fire damp and coal dust.

4.—The experiments have shown that ignitions of mixtures of air and coal dust, with or without the presence of fire damp, can be obtained when there is present a much smaller quantity of coal dust than has been previously supposed to be necessary.

5.—It is essential that similar examinations of the working places and precautions which are in force in mines where blasting powder is used should be rigidly observed where a high explosive is employed.

6.—In selecting a high explosive for use in a mine, it should not be forgotten that the risk of explosion is only lessened and not abolished by its use.

7. In view of the changes from time to time made in the proportions and constituents of high explosives, it is desirable that the name of the explosive should be printed on the wrapper of each cartridge,



and that the date of manufacture and the proportion of the ingredients used in the manufacture of the explosive should be printed on the case of each packet of cartridges.

8.—As these explosives alter in character if improperly kept, it is necessary that every care should be taken in the storage to insure their being maintained in good condition.

CERTAIN PROPERTIES OF ROENTGEN'S RAYS.

By Jean Perrin.

I will admit at once that I have had only very vague information drawn from the daily papers concerning Prof. Roentgen's discovery, and that I am still in ignorance as to the exact nature of his experiments.

However it may be, here are those which I have attempted.

I. I have first repeated that which constitutes the discovery; if we place, in presence of a Crookes tube in activity, a photographic case charged and closed, on which are arranged different objects, and if in these develop the plate in the ordinary manner, we see appear the shadows of certain of these objects; something which emanates from the tube has impressed the plate through the interposed bodies. This is Roentgen's radiation.

These rays are not cathode rays; these latter cannot, in fact, issue from the vacuum tube except through a wall of some microns in thickness; while Roentgen's rays act easily out of a tube the side of which may have the thickness of 1 mm.

II. I then collected some indications as to the degree of transparency of different substances.

Wood, paper, wax, paraffin, water, appeared very transparent, though the influence and thickness remained very distinct. Then come, arranged in the order of increasing opacity, coke, bone, ivory, spar, glass, quartz (either parallel or perpendicular to the axis), rock salt, sulphur, iron, steel, copper, brass, mercury, lead. These results are still not numerous, and I cannot think of combining them by general law; still we may remark that the metals are in general less transparent than the substances, but have not the absolute opacity which they present for light. If, e. g., we superimpose three plates of iron, each of about 0·2 mm. in thickness, opacity appears only in the region covered by all three plates.

III. I then made a rather rough experiment in order to find if the radiation is well defined, or if it merely forms a diffused tuft; in a word, I have examined if its propagation is rectilinear.

To this end I placed before the tube two diaphragms of brass (which is opaque), at the distance of some centimeters, on a sensitive plate placed a little further. I obtained a very definite spot with an umbra and a penumbra, and the dimensions of this spot agree with the hypothesis of rectilinear propagation.

It is therefore possible to isolate definite pencils, the properties of which will be studied.

IV. I have attempted the reflection of a pencil of Roentgen's rays, defined by two slits of 0·5 mm. at the distance of 4 cm. The pencil fell upon a mirror of polished steel at an angle of 45°, whence after reflection it could fall upon a filled frame. After an hour's exposure I obtained absolutely no impression.

The experiment was repeated with a plate of flint glass as a mirror. The exposure was prolonged for seven hours, but absolutely nothing was obtained.

V. I attempted the refraction of Roentgen's rays. In the lower half of the pencil, defined by the system of slits, I interposed first a prism of paraffin of 20°, and a prism of wax at 90°. The two parts of the pencil should give distinct images if refraction took place; but the two images were prolonged exactly, and we may affirm that if any deviation exists it is inferior to 1°.

VI. Continuing to seek for some properties of Roentgen's rays capable of coexisting with a rectilinear propagation, I attempted to form diffraction fringes.

The active part of the tube was placed before a very narrow slit; at 5 cm. further was placed a slit of 1 mm., and at 10 cm. further the frame fitted and closed. The exposure was continued for nine hours. I obtained an image with very distinct margins, on which no fringe was perceived.

I placed, exactly at the place of the former plate, a second sensitive plate, and operated this time with an open frame, so as to receive the green light issuing from the tube. After some minutes this light gave a silhouette, exactly superimposed on the former, but on which fringes were seen.

If, therefore, the phenomenon is periodic, the period is much lower than that of the green light employed.

It is well to observe that this experiment, made very accurately, proves the rectilinear propagation of Roentgen's rays. Around this property which they possess more strictly than light are grouped those mentioned in this paper.

VII. Lastly, being curious to see what practical interest might attach to the silhouettes obtained, I experimented on some living tissues, with the assistance of M. Oligny, preparer of zoology at the Ecole Normale of M. Mouton, an attache of the museum. We have the honor of presenting to the academy two proofs which represent very faithfully the skeleton and some organs of a flat fish (Pleuronectes) and of a frog.

M. Poincare made the subjoined remarks: Prof. Roentgen has already recognized that the X rays are not refracted; he has experimented with prisms formed of different materials; on one occasion only he thought that he observed a slight deviation, corresponding to an index of 1·05; but this observation remains doubtful. He has likewise seen that the rays do not undergo a regular reflection, but he believes that they may experience an irregular and diffusive reflection.—Comptes Rendus, cxxii, p. 186.

THE CATHODE RAYS.

By Jean Perrin.

Two hypotheses have been proposed to explain the properties of the cathode rays.

Some authorities think with Goldstein, Hertz and Lenard, that this phenomenon is due, like light, to the vibrations of the ether, or even that it is light with a short wave length. Others, Crookes and J. J. Thomson, consider that these rays are formed of matter charged negatively and traveling with great velocity. From a paper courteously forwarded us by the author, we learn that, according to his experiments, the facts observed do not easily agree with the theory which regards the cathode rays as ultra-violet light. On the contrary, they are in harmony with the theory which regards them as a material radiation.—Chemical News.

PERMEABILITY OF METALS FOR THE X RAYS.

By V. Chabaud.

I have examined fourteen common metals or alloys as regards their permeability for the X rays. The results obtained are shown on the photographs which I have the honor of submitting to the academy.

The metals examined have been rolled out to the thickness of 0·2 mm., and cut up into rectangular slips 35 mm. in length and 7 in width and attached side by side and in a parallel position on one and the same cardboard. In addition a slip of platinum of $\frac{1}{10}$ mm. in thickness is superimposed as a check, intersecting the other slips transversely.

The sensitive photographic plate was protected against light by a double layer of black paper. The system of metal slips was laid against this paper during the exposure. The time of exposure was forty-five minutes and the length of the sparks of the exciting coil was 7 cm.

The metals thus compared were the following: Lead, zinc, copper, zinc amalgam, tin, steel, gold, silver, aluminum and platinum.

The experiment showed that, at the thickness of 0·2 mm., platinum alone is perfectly opaque. Aluminum, as is already known, is very transparent.

The other metals above named are appreciably transparent.

Platinum itself, at the thickness of $\frac{1}{10}$ mm., is easily permeated, since the cheek band threw a slight shade upon the paper. This shade was seen traversing all those projected by the other metals, which shows their transparency.

Mercury deserves a special place. At the thickness of 0·1 mm. it appears as opaque as platinum. In order to obtain a plate of mercury of this thickness, I employed a trough hollowed in wood, 0·1 mm. in depth, closed with a plate of varnished glass. It remains to be seen if, at the thickness, e. g., of $\frac{1}{10}$ mm., mercury in turn will appear transparent like platinum.—Comptes Rendus, cxxii, p. 237.

ON THE UTILITY OF PHOTOGRAPHS IN HUMAN PATHOLOGY TAKEN BY MEANS OF THE X RAYS.

By MM. Lannelongue, Barthelemy and Oudin.

The communication of Oudin and Barthelemy on this subject has led us to undertake some researches with a view of confirming our first results, and also of ascertaining what advantage we may obtain by the employment of Roentgen's rays.

We have therefore undertaken the researches, the first results of which I am about to lay before the academy. Our appliances are as yet imperfect, and we are aware of our own inexperience.

The first fact is that of an anatomical case. It is that of a thigh bone attacked with osteomyelitis. One of us has shown elsewhere that the malady known under this name is wrongly considered as a periostitis.

If this were true, the bony alterations would have produced themselves from the surface to the center of the bone. The photograph shows, on the contrary, that the surface of the bone is intact, while the internal layers are destroyed as far as half a mm. from the surface.

Normally the compact osseous tissue, here reduced nearly to the thickness of a piece of paper, should have at least half a cm. in thickness. This has allowed it to be traversed by the light, and this is the cause of the white spots remarked on the bone.

The second photograph is that of a tubercular affection of the first joint of the middle finger of the left hand.—Comptes Rendus, vol. cxxii, p. 159.

EXPERIMENTS WITH ROENTGEN'S RAYS.

By Albert Nodon.

The voltaic arc produced in the air does not emit to an appreciable extent radiations having the property of traversing opaque substances like the rays of Roentgen.

A sensitive plate (silver gelatino-bromide) infolded in substances opaque to light, e. g., several thicknesses of black paper, and then exposed for fifteen minutes to the direct radiations of an arc of 20 amperes at the distance of 0·40 meter, showed on development no sensible impression, while under the same circumstances it revealed a very distinct action of Roentgen's rays.

This result seems to demonstrate that the ultra-violet radiations of the spectrum in which the arc is rich do not appreciably traverse opaque substances.

Various colored media are traversed by Roentgen's rays with equal ease. The experiment was made with a screen of leaf zinc perforated with apertures, before which there were arranged respectively plates of colored gelatin, which transmitted only very limited portions of the spectrum. One of these apertures was kept open and another was covered with uncolored gelatin. After exposure to Roentgen's rays behind a screen of black paper, the photographic plate showed on development equal impressions produced through the various apertures.—Comptes Rendus, cxxii, page 237.

ON THE APPLICATION OF ROENTGEN'S RAYS IN SURGICAL DIAGNOSIS.

By MM. Lannelongue and Oudin.

It is necessary to ascertain to what degree the new rays can traverse the most compact parts of the human body, to show the state of the hard portions found there. To this end we have taken the thigh and the knee—the first time, we believe, that the attempt has been made. The two subjects had tedious affections of this region of the body, and it was interesting to know if the diagnoses which had been carefully made beforehand would be confirmed by the new method of investigation.

The first subject is now cured of an osteo-arthritis of the left knee, of a tuberculous nature, which had required three years of successive treatment.

The second photograph which we present is that of the thigh of a child of 8 years of age, who had suffered from osteitis of the femoral diaphysis. He is now cured, and walks perfectly well.

The examination with the new light did not afford any novel information which had escaped notice, but it confirmed in all points the indications arrived at clinically.—Comptes Rendus, cxxii, p. 283.

INFLUENCE OF THE CHEMICAL NATURE OF SUBSTANCES, AND THEIR PERMEABILITY BY THE ROENTGEN RAYS.

By Maurice Meslans.

Numerous experiments have demonstrated that certain bodies are transparent to the radiations emitted by the Crookes tube, while others present as regards these rays a relative opacity. I have undertaken to examine what is the relation which may exist between the transparency of these substances and their chemical nature, and if the Roentgen rays may not furnish a new means of investigation in the domain of chemistry. I will here merely indicate the most striking of the results which I have obtained; they are manifest on an examination of the photographic proofs which I submit to the academy, and which refer to about fifty substances, simple and compound. These results, though incomplete, seem to me to offer some very definite conclusions, and determine me to pursue this study further.

The transparency or opacity of bodies to the X rays is not absolute; the influence of thickness has been already demonstrated, and the role of density has been examined. The specific chemical nature appears to me to present a very considerable influence. I have compared together the various nonmetallic bodies as

well as their acid derivatives, and the salts, metallic or organic, which they yield. My experiments have related chiefly to organic bodies, and to their essential element, carbon.

I have been hitherto able to establish the extreme transparency not merely of carbon in its different states, compared to those of other nonmetals, the slight opacity of organic compounds when along with carbon they contain merely the gaseous elements, hydrogen, oxygen, and nitrogen. Still this transparence is far from being uniform, and presents very various degrees which appear connected with the chemical function of these bodies.

The photographic proofs which accompany this memoir have been obtained by shutting up a photographic plate in a frame for negatives, and arranging upon the little board which covers the plate the substances whose transparence it was desired to study, lighting up the whole with a Crookes tube, placed at a distance of 20 cm. After an exposure of thirty minutes, the plate and development gave silhouettes of the bodies experimented upon, the relative intensities of which measured their transparence.

Diamond, graphite, anthracite, sugar charcoal, give a faint tinge of a tonality similar to that of wood or of paraffin of an equal thickness, while sulphur, selenium, phosphorus, iodine, afford very strong images of great opacity.

The organic substances, ethers, acids, nitrogenous substances, were easily traversed by the X rays, and gave images scarcely perceptible; but the introduction into the organic molecule of a mineral element, such as iodine, chlorine, fluorine, sulphur, phosphorus, etc., gives to the molecule a great opacity.

The sulphates of the alkaloids are in this case. In like manner iodoform is very opaque, while the alkaloids, picric acid, magenta, and urea are very transparent. Phthalyl fluoride is much more opaque than phthalic acid, although the molecular weights of the two bodies approximate very closely. The metallic salts possess a great opacity, but which varies with the metal and the acid.

These results are corroborated by the photography of hands and of small entire animals executed by Prof. Roentgen and others. In these proofs the muscles remain transparent. They are, in fact, substances formed entirely of carbon, hydrogen, oxygen and nitrogen. The bones, on the contrary, give strong images. The opacity is due to the mineral elements which they contain.

The differences in the chemical constitution of the matters forming nerves, blood, etc., will doubtless permit us to obtain their photographic images, thanks to their unequal transparency.

I hope to carry out with more exactitude these researches on definite chemical species, and I purpose studying the relation between the chemical constitution of bodies and their degree of transparency to the Roentgen rays. At present the result which seems established is the transparency of carbon and its compounds with hydrogen, oxygen and nitrogen, and the great opacity occasioned by the introduction into the organic molecule of other mineral elements, especially Cl, S, P, and above all, I.—Comptes Rendus, cxxii, p. 309.

PROOFS OBTAINED BY MEANS OF ROENTGEN'S PROCEDURES.

By H. DUFOUR.

THE hand of a child, the fingers of which were garnished with rings of brass and aluminum, yielded a proof in which we distinguish the projection of the rings, the outline of the skin, the structure of the bones, and in particular the incomplete ossification of the last joint of the little finger.

The photograph of a frog permits us to distinguish the bones of the pelvis, of the limbs, and to some extent those of the head.

The proof of a trough with parallel sides, partly filled with blood, showed merely a scarcely perceptible difference of intensity between the empty portion and that occupied by the liquid.

Ch. V. Zenger addressed a note regarding the recent experiments of Prof. Roentgen.

The author recalls attention to his own communications made to the Academy of Sciences in February and August, 1896; the photograph of Mont Blanc which he obtained by night at the distance of 80 kilometers. He also drew attention to the researches of Hittorf, Hertz and Ayrton, who have shown the permeability of plates of sulphur, vulcanite, plaster, etc. According to him, the cathode radiation is merely the invisible ultra-violet radiation produced in the rarefied space of the Crookes tubes, and it has been already demonstrated that it is arrested by metallic plates. These radiations can develop fluorescence and phosphorescence in bodies which are opaque to the radiations of greater wave lengths.—Comptes Rendus, vol. cxxii, p. 213.

ELECTRICAL PHENOMENA PRODUCED BY THE ROENTGEN RAYS.

By A. RIGHI.

IN the Comptes Rendus for February 3 I find a communication, by MM. Benoist and Hurmuzescu, on the dissipation of electric charges obtained by the Roentgen rays. As I have executed similar researches at the same time as these physicists, and have communicated them to the Academy of Sciences of Bologna at its last session, and as my results are not entirely identical with those of Benoist and Hurmuzescu, I solicit permission to give here a summary.

I have used a Mascart electrometer as a measuring apparatus. It is in connection with the substances upon which the X rays are caused to fall, and which emanate from a Crookes tube inclosed along with the apparatus yielding the discharges in a large metal case connected with the earth. The part of the case which is close to the tube is formed of a thick sheet of lead, having in the middle a round window of 1 cm. in diameter, covered with a slender plate of aluminum, whence the rays issue.

I have found that a metallic disk communicating with the electrometer rapidly loses its charge, whether positive or negative. The duration of action necessary for the potential to fall from 7 to 3·5 volts is sensibly alike for a positive and for a negative potential.

With an initial positive charge the discharge is not complete; with a negative, the substance is not merely discharged, but there is formed a positive charge.

If I cause the Roentgen rays to fall upon one of my photoelectric couples which are formed of a metallic tissue in connection with the earth, parallel and very near to a metallic disk in connection with the electrometer, I obtain deviation which is positive or negative, according to the nature of the metals of the couple, as with the ultra-violet rays.

A disk in its natural state is charged positively, if exposed to the new radiation (which takes place also on employing the ultra-violet rays). With this same disk the final positive potential is the same, whatever may be the initial value of the potential of the disk—positive, negative, or null. This final potential is higher for copper than for zinc, and still higher for retort coke.

I find, besides, that a plate of glass, being nearly 1 cm. in thickness, if placed on the path of the X rays, does not destroy their action, but enfeebles it appreciably. In the same manner the interposition of a thick plate of aluminum, or a thick board of deal, or even of the hand laid so as completely to cover the window, merely enfeebles more or less the action of the rays. I expect that similar results will have been obtained by other physicists.—Comptes Rendus, cxxii, p. 376.

EDISON'S ROENTGEN RAYS EXPERIMENTS.

By EDWIN J. HOUSTON and A. E. KENNELLY.

MR. THOMAS A. EDISON, after numerous experiments on the Roentgen rays with about 150 different glass vacuum tubes, has communicated the following information to us for publication:

First. There is no apparent advantage in obtaining a very high vacuum in the Crookes tubes employed for obtaining shadowgraphs of metal gratings. The

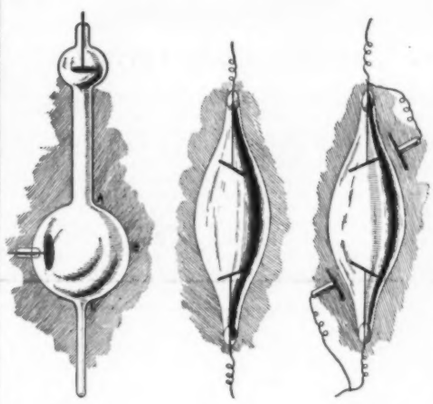


FIG. 1. FIG. 2. FIG. 3.

FORMS OF RAY LAMPS.

effect of a very high vacuum is to require a greater voltage to produce fluorescence. The best degree of vacuum seems to be that at which the internal luminescence or striæ in the tube just disappear and fluorescence of the walls remains. The Roentgen rays are still produced even when internal striæ are observed, but are then much enfeebled.

Second. Thin walls are preferable to thick walls in the glass vacuum tubes. A thick wall will fluoresce more noticeably and become very hot. A thin wall will emit rays upon the photographic plate, but may scarcely fluoresce visibly and will remain very cool. This is proved by a number of experiments, of which the following is one: The tube of a shape roughly indicated in Fig. 1 has its walls blown thick in the zone of A C, but thin at B. When this tube is exhausted and excited, the thin part, B, which is in the most active area, remains cool and the radiographic power is active, while the glass becomes hot in the ring, A C. If B be made thick and A C thin, the glass at B may become melted by the heat, but its effect on a photographic plate is reduced, although its visible fluorescence is greater. Walls one-eighth of an inch thick become unmanageable by excessive heating and rapid melting.

Third. For any given tube in a given condition of exhaustion the radiographic power of the tube, i. e., the swiftness with which is produced a developable image, is roughly proportional to the square of the fluorescent candle power or total visible fluorescent light given out by the tube.

Fourth. The duration of exposure has been found to be as follows: With the most sensitive plates in an ordinary plate holder having a vulcanized fiber light-tight cover of about $\frac{1}{17}$ of an inch in thickness, the time necessary for obtaining a good radiograph of a metal grating or grid is less than one second, when the tube is within $\frac{1}{4}$ of an inch of the grating and about $\frac{3}{4}$ of an inch from the sensitive plate. At two feet distance the time for an equally good radiograph is approximately 150 seconds, and at three feet 450 seconds. For rough purposes the duration of exposure may be reckoned as proportional to the square of the distance.

Fifth. Of the photographic plates, as ordinarily employed for photographic purposes, the medium rapid plates appear to be the most suitable for Roentgen rays; i. e., to require less duration of exposure. Rapid plates and slow plates appear to be equally unfavorable in regard to sensitiveness for Roentgen rays as compared with medium plates. To test this a composite sensitive plate was made from five strips cut from plates of different photographic sensitiveness, and a radiograph of a series of metal bars was taken, with the bars at right angles to the strips of the composite plate. For the same exposure and same development the definition of the radiograph produced did not bear any apparent relation to the photographic sensibilities of the strips according to their sensitometer numbers. The medium rapid plate gave, however, much the densest image in every such experiment.

Sixth. The power of a tube having a given degree of exhaustion and disposition of electrodes increases with the surface area of its fluorescent walls; thus a large vacuum tube exposing a large total fluorescent surface has a more rapid action on the sensitive plate, i. e., requires less exposure, but will require more voltage and more electric power to excite. On the other hand, for a given distance of the tube from the plate, the image is sharper and less distorted as the tube diminishes in size. Consequently, for a given tube used without a diaphragm, long distance and long exposure produce the sharpest radiograph. A small tube will produce a sharp image at a lesser distance, and for rapid exposures a very small tube at a very short distance is the best. The smallest tubes experimented with have been about one inch in diameter, with about two inches between electrodes, and with thin glass walls. A small tube requires a small E.M.F., so that tubes can be made to suit almost any induction coil.

Seventh. For a given thickness of glass wall, German glass appears to give better results than lead glass. The German glass employed gives a yellowish fluorescence, while lead glass gives a greenish fluorescence. These glasses phosphoresce visibly for at least ten minutes after the cessation of the discharge through the tube. A particular quality of Scotch boiler water gage glass used gives apparently equally good radiographic results, but does not appreciably phosphoresce after the cessation of the current. The residual phosphorescence has not yet been found to produce a visible photographic image. All phosphorescence yet observed is pale white, whatever the color of the preceding fluorescence under excitation.

Eighth. The form of the tube arrived at by a gradual process of selection is shown in Fig. 2. The length is about three times the diameter. This tube is made in various sizes. When the glass walls are thin for producing the best radiographic effect, a spark is apt to pierce the wall and destroy the vacuum. Partly on this account, tinfoil caps are placed over the extremities of the tube, as indicated by the shaded areas in the sketch. These tinfoil caps are in connection with the electrodes, and are cemented to the external surface of the tube by shellac.

Ninth. It was found in numerous trials with many tubes that the fluorescent and radiographic power of all the tubes without caps was greatly increased, roughly doubled, in fact, by bringing two metallic disks, connected with the respective electrodes, to the opposite points, represented in Fig. 3. The supposition is that the tube thus becomes at once an ordinary and electrodeless tube combined. The metal caps above mentioned were the outcome of these experiments, and not only have all these capped tubes remained unperforated, but their fluorescent and radiographic powers have been enhanced by the caps. The caps serve three purposes: (a) To stop piercing by permitting excessive sparking to escape over the external surface. (b) To increase the radiographic and fluorescent power. (c) To prevent undue heating of the internal electrodes, and a consequent charge of vacuum.

Tenth. The exciting apparatus consists of a large Ruhmkorff coil capable of giving a 12-inch spark, although such a length of spark is rarely required. The coil is excited either from a storage battery through an interrupter, or preferably from a 120-volt continuous current circuit, through a bank of from 8 to 20 16-c. p. incandescent lamps arranged in parallel, with a rapidly rotating wheel interrupter driven by a small motor. About 400 interruptions are made per second, and the duration of closure in the circuit is twice that of opening. An air blast is directed upon the spark over the periphery of the interrupting wheel through a fine nozzle. This tends to produce a sudden breaking of the circuit. It has been found that greatly improved results have followed the removal of the usual condenser and the substitution of the air blast. The resulting secondary E. M. F. is almost symmetrical, like an alternating E. M. F., and the two electrodes are apparently equally active. The secondary terminals of the induction coil are led directly to the vacuum tube. If the air blast is removed and the condenser substituted, the fluorescent and radiographic power of the tube is greatly diminished.

We believe that these observations of Mr. Edison cannot fail to be valuable to many practical workers with Roentgen rays. We hope to communicate further experimental results at some future time.—The Electrical World, to whom we are also indebted for the illustrations.

ON THE DEPRESSION OF EXPLOSIVE POTENTIALS, STATIC AND DYNAMIC, BY THE X RAYS.

By M. R. SWYNGEDAUW.

THE analogy between the ultra-violet rays and the Roentgen rays has led me to try the action of the latter upon the explosive potentials. Experiment has shown that the X rays lower explosive potentials according to the same general laws as the electrically active ultra-violet radiations.

The depression of the static explosive potentials is measured directly with the electrometer of Bichat and Blondlet, noting the explosive potential of the exciter, when illuminated by the rays or not illuminated.

The Crookes tube is traversed by the discharge of a Ruhmkorff coil actuated by two accumulators; it is placed parallel to the exciter, and at the distance of 25 cm. from the latter. The exciter is formed of two iron spheres of 1 cm. in diameter.

In an experiment where the explosive distance is 5½ meters, the exciter is discharged for a potential of 60 C. G. S. units, if not illuminated by the X rays. Under the influence of these rays the spark strikes at a potential of 58·8 C. G. S.

A black paper, a plate of glass or of wood, do not

change, in an appreciable manner, the depression of the explosive potential.

A plate of brass, of the thickness of 0·5 mm., completely suppresses the explosion.

The depression of the dynamic explosive potential is measured by the method of the two derived exciters formerly described (Comptes Rendus, February 3, 1896). For the arc lamp we substitute the Crookes tube; we place an opaque screen for the radiation (e. g., a plate of brass), between the two derived exciters, E_1 E_2 and N_1 N_2.

Still in this form the method gives only negative results. This depends on the fact that the illumination with the Crookes tube is necessarily intermittent, and lasts only for a very small fraction of a second; a very fortunate coincidence is required for the tube to be illuminated at the moment of the dynamic charge of the exciters.

To evade this difficulty I employ an artifice by means of which the Crookes tube is illuminated at the same time as the derived exciter is charged by the dynamic method (discharge of the condenser, GC_2).

In the secondary circuit of the Ruhmkorff coil we place a Crookes tube and a secondary exciter, S. This exciter is placed at the distance of 4 cm., and opposite the poles of the principal exciter, I_1 I_2, which allows the charge of the condenser. The Crookes tube is placed opposite E_1 E_2, at the distance of about 25 cm.

We actuate the Ruhmkorff coil; at each spark which strikes in S the coil discharges itself through the Crookes tube.

We charge the condenser slowly with Holtz machine; when the potential of the exciter, I_1 I_2, is close upon its static explosive potential, the one of its sparks which burst in S excites, by its ultra-violet radiations, the discharge of the exciter, I_1 I_2, and of the condenser, and the derived exciters, E_1 E_2 and N_1 N_2, are charged dynamically; E_1 E_2 are two rings of iron of 1 cm. in diameter; N_1 N_2 are two rings of brass, also of 1 cm. in diameter.

If N_1 N_2 = 3 mm., the spark still bursts at E_1 E_2 when the explosive distance of E_1 E_2 is 5·40 mm. under the influence of the X rays.

In the absence of these rays the poles of E_1 E_2 must be brought to the distance of 3 mm., so that the spark may burst at E_1 E_2 rather than at N_1 N_2.

The interposition of a screen of paper or of glass does not diminish the depression in an appreciable manner. A plate of brass suppresses it entirely.

The spark of the same Ruhmkorff coil produces a lowering of the same order of magnitude if no screen is interposed between the exciter and the spark. A screen of wood, glass, or black paper arrests the active ultra-violet rays.

From these experiments we shall draw the following conclusions:

I. When measuring the depression of the dynamic explosive potentials by the method of the derived exciters, we may detect with great distinctness the X rays.

II. The Roentgen rays lower the dynamic explosive potentials in much greater proportions than the static potentials.

—Comptes Rendus, cxxii, p. 374.

ACETYLENE APPARATUS.

By T. O'Conor Sloane, Ph.D.

Much interest has been excited by acetylene gas—the easy production of the brilliant illuminant by simple treatment of calcium carbide with water has enabled any one to perform the simple experiment. But to enable the gas to be properly generated and burned satisfactorily, some adequate apparatus is required, and in the present article we give two different forms of apparatus—the first of the utmost simplicity, yet quite adequate for demonstration, the next of construction adequate for use on the large scale. The second apparatus fitted with proper condenser, or even with separate inlet and outlet tubes, for the gas holder presents all the requirements of an industrial gas plant. As shown, it has capacity for quite long operation; the addition of proper condensing apparatus to remove water from the gas is all that is needed to make it capable of running for hours.

Few chemical discoveries have attracted more interest than the recent one of the method of manufacturing acetylene on a large scale. The production of the calcium carbide from which the acetylene gas is made by simple treatment with water bids fair to become a commercial process, and we have every reason to hope that the material will soon be produced by the ton. There is something fascinating in the idea of being able to evolve a gas of about 300 candle power by so simple a process. While the crudest possible apparatus, such as a tumbler of water, is sufficient to illustrate the production of the gas, the object of the present article is to show how a better demonstration can be produced with very simple appliances.

To show the gas with a tumbler of water, it is sufficient to drop into it a piece of the calcium carbide as large as a pea; the gas is at once evolved in large quantity, and a match can be applied repeatedly to the accumulation of bubbles on the surface of the water, giving a number of successive lightings. The apparatus illustrated in the cut (Fig. 1), which gives more satisfactory results, is constructed from a battery jar and lamp chimney as the principal elements, and is made on the lines of the old hydrogen evolution apparatus.

To the top of the lamp chimney, which should be of large size, a cork should be tightly fitted. Unless the cork is better than the majority, it should be waxed or paraffined, which is very easily done by placing some fragments of wax or paraffine on it and melting the material with a hot soldering iron or poker. Through a central perforation a tube is inserted fitted with a stop cock and a gas burner; the latter must be of the smallest size made, the Bray fishtail burner answering about the best of any yet tried. Merely to exhibit the gas, a simple jet may be made by drawing a glass tube almost to a point or by drilling a very small hole in a cap fitted to the pipe leading from the stop-cock. Through a hole a little to one side of the evolution pipe a wire passes which moves up and down with some friction through the hole. Its lower end is formed into a hook, to which is suspended a little basket made by bending up a little bit of coarse wire gauze. A piece with one-quarter inch meshes will be about right. The suspending wire is bent at the top to give it a better handle.

To operate it, the lamp chimney is placed in the jar, the water is poured in until within an inch or two of the top, and a piece of calcium carbide half the

Fig. 1.—SIMPLE ACETYLENE APPARATUS.

size of a walnut is placed in the basket, which is drawn up until pretty close to the cork. The cork is now placed in the lamp chimney and pressed down so as to make it fit tightly, and the wire slowly worked down until the basket becomes partially immersed in the water. The level of the water is at once depressed as the gas is evolved, and if the cock is open the air and gas within the chimney begin to escape. As soon as the odor of the escaping gas is strong, it can be lighted and will burn for five or ten minutes with great steadiness. If the pressure decreases and the water rises, it comes in contact with the calcium carbide, more gas is evolved, and it falls again.

The apparatus may be further simplified by omitting the stopcock, which is unnecessary, and a bucket may be substituted for a battery jar. It may also be necessary to secure the chimney against floating upward, although in the apparatus shown this is quite unnecessary.

It is well before lighting the gas to hold a test tube over the outlet for a few seconds until filled with the gas, and to light it with a match or at a gas burner. If the contents do not explode, it is safe to light the jet on the chimney; if it does explode, the lighting should be deferred until purer gas is evolved. Two or three minutes are sufficient to get it in working order. It must also be remembered that it is essential to have a very small burner, as otherwise the gas will smoke and the supply will be insufficient to obtain a satisfactory flame. The suspending wire must fit tightly, as if it slips down, the apparatus will blow out or overflow. A very slight immersion of the carbide starts it.

This apparatus was originally described and illustrated in the Scientific American of March 30, 1895. At the Atlanta Cotton Exposition practically the same apparatus was shown on a larger scale, both being, it will be observed, reproductions of the familiar hydrogen evolution apparatus. The illustration (Fig. 2) shows the construction of the apparatus as shown there.

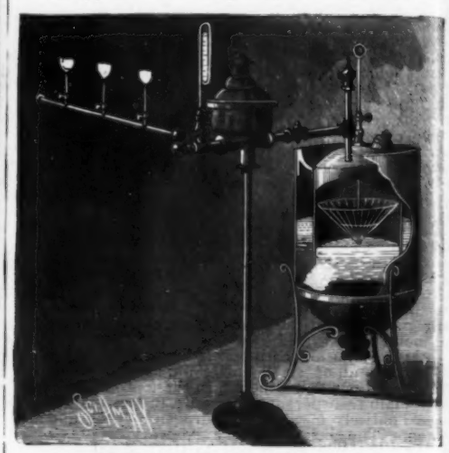


Fig. 2.—SECTION OF GAS EVOLUTION APPARATUS, ATLANTA EXPOSITION.

A very simple apparatus for the production of acetylene gas, which, if the proper proportions are preserved, will work automatically for many hours, is illustrated in next cut (Fig. 3).

The general requirements for a successful acetylene

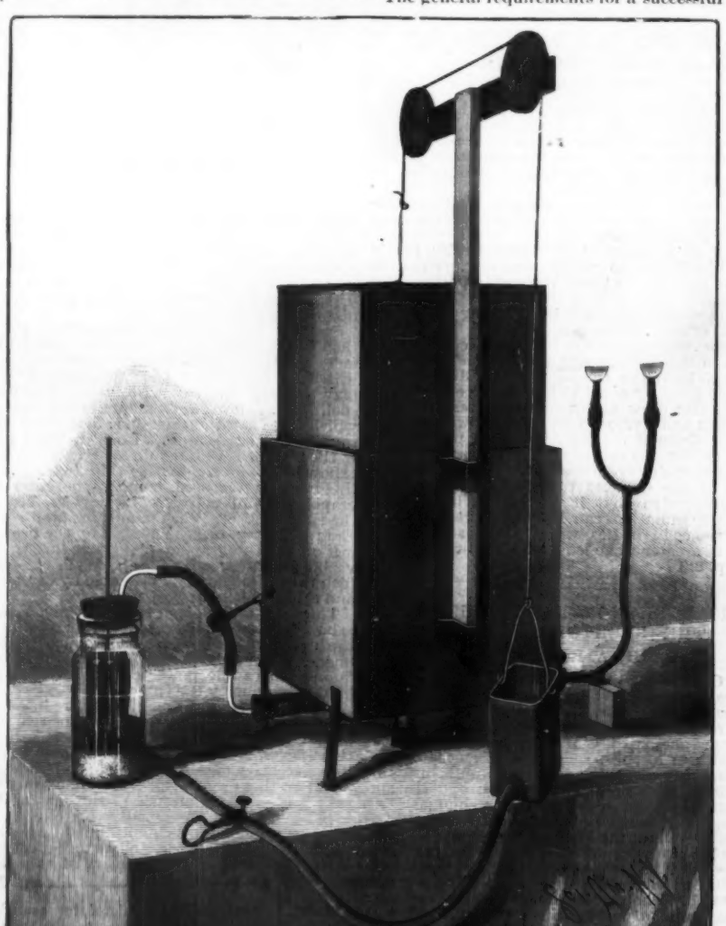


Fig. 3.—ACETYLENE GAS PLANT.

gas apparatus make a gas holder of some kind almost a necessity. The varying level water pressure apparatus which we have just shown are unsatisfactory, except as regards their simplicity of construction. In apparatus of their type, when the calcium carbide is to be replenished, complete cessation of the gas delivery is required; and after the replenishing has been effected some little time is required to get the apparatus into working order again. From considerations of safety it is also in accordance with good practice that the apparatus shall automatically remove the water from the carbide when the evolution is too rapid.

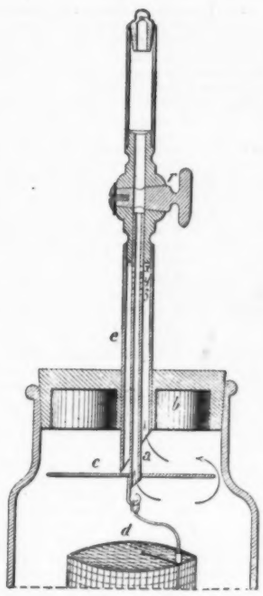
In the apparatus shown, the gas holder, of about one-half cubic foot capacity, is arranged for the storage of the gas, and with this gas holder is connected the evolution pipe and the apparatus in which the gas is produced. An excellent gas holder can be made, as was the one shown, out of two biscuit boxes, one inverted within the other. A single pipe passing through the bottom of the outer vessel is carried up to its top, and from this pipe the inlet and outlet pipes branch off below the bottom of the tank. The gas holder proper floats like an inverted bell on the water contained in the tank.

All this part of the construction is the regular gas holder construction as used by gas engineers. From the center of the gas holder bell a cord is carried upward, passing over two pulleys on a simple frame and then hanging down, and from its outer end depends a water vessel. This may be weighted, if necessary, to act as a counterpoise, but its object is primarily to supply the element of safety in providing means for automatically removing water from the carbide.

The evolution apparatus consists of a wide mouthed bottle with tightly fitting cork. Through an aperture in the center of the cork a tightly fitting rod passes which carries at its lower end a basket of wire gauze. In this basket the carbide is placed. A second tube passing tightly through another aperture in the cork leads to the gas holder. If this bottle is half filled with water and the basket is lowered until the carbide touches the water, the gas will at once be evolved with astonishing rapidity and the gas holder will rise. As it reaches approximately the proper height, the wire could be drawn up by hand and the evolution stopped, but to avoid this necessity a connection is made between the vessel suspended from the string of the gas holder bell and the evolution bottle. A hole is drilled through the glass of the bottle about half way up the side and a rubber tube is tightly fitted in this aperture. If the tube does not make a watertight joint, a glass tube can be forced through the rubber one to compress it against the glass of the bottle. From this aperture a rubber tube leads to a nipple in the bottom of the suspended vessel. The effect of this is that as the holder rises the suspended vessel descends and presently begins to receive water from the evolution bottle, so that as the holder reaches its upper limits an inch or more depth of water will be withdrawn, leaving the carbide of calcium above the surface.

The mode of operation is obvious. The bell of the gas holder is placed at its lowest position, the carbide basket is charged with some lumps of carbide, the cork is placed in the bottle and the wire is forced down by hand until the bottom of the basket is a quarter or half an inch beneath the surface of the water. The gas rapidly evolves and the holder rises. If the evolution is too rapid, the basket may be raised. In a few minutes the holder is full and the suspended vessel contains perhaps half the water. Now the basket is lowered until its bottom is about at the water level or perhaps a shade lower. If the holder descends, more water runs into the evolution bottle and gas is produced; if the holder rises, the water leaves the carbide, thus automatically causing the evolution to cease. An approximately constant level of gas holder is thus maintained with an almost exactly constant pressure.

If it is necessary to replenish the carbide basket, all that is necessary is to close, by means of the spring wire pinch cock, the communication between the gas holder and evolution bottle. If the gas is being burned, this does not interfere with its delivery. After the new material has been introduced the basket can be replaced and lowered, and all will go on as before. As considerable calcium hydrate accumulates, the water connection is made well up the side of the evolution bottle, to keep the solid material out of the India rubber tube. The bottle may be cleaned out from time to time by shutting off the two spring cocks if necessary, or at any rate the one on the gas evolution tube, leaving the operator free to uncork and to wash out the evolution apparatus. It is well also to give the carbide basket a thorough cleaning between the additions of the carbide.



FIGS. 4 AND 5.—TROUVE'S ACETYLENE LAMP.

FIG. 6.—THE FULLER ACETYLENE GENERATOR IN USE FOR READING AND MICROSCOPY.

FIG. 7.—THE FULLER ACETYLENE STEREOPTICON BURNERS.

It is hardly a matter of surprise that one of the most artistic and convenient examples of the uses to which this new material as an illuminant can be put is due to the ingenuity and good taste of the French. The lamp shown in the accompanying illustration is from the laboratory of Mr. G. Trouvé, the well known French scientist, and shows the practical form in which the lamp may be constructed to render it available as a portable lamp for domestic uses. Before, however, such a lamp is introduced into general use in the family the fact of its absolute safety and impunity from accident must be assured, and such an end will be reached in time, no doubt, by experiment and by perfecting the apparatus. It is described in La Nature, to which journal we are indebted for our illustrations.

It is interesting to notice the credit given in La Nature to the original lamp chimney apparatus, described above, as being the first acetylene lamp produced. La Nature speaks of it as the first acetylene lamp ever made.

G. Trouvé's lamp, Figs. 4 and 5, of an exceeding simplicity, consists of two glass vessels, one fitting within the other, and of a metal part closing the top, to the center of which top is connected the jet or burner tip.

In the interior vessel, which is practically a bottle with a large neck, is suspended a little metal basket which holds the calcium carbide; the bottle in question has a conical opening in its bottom, the size of which orifice depends on the use to be made of the lamp, so that the movements within this bottle, which acts as a bell jar, shall not be too sudden, depending as they do on the speed of entrance and outflow of the liquid. Under these conditions the flame and its intensity are fixed.

Acetylene, depending on contact with water for its formation, carries off a quantity of vapor of water, which must be instantly condensed so as not to interfere with the proper action of the lamp, whose burner, as in all portable lamps, is very near the generator. Mr. Trouvé first tried to obtain this result by means of a condenser with large metallic surface, namely, a spiral ribbon, and later by a still simpler arrangement shown in Fig. 5.

He uses two concentric tubes, a e, cut off obliquely and connecting with the cock, r. At first the gas passes by both tubes to the burner, as is shown by the arrows, but as soon as the vapor condenses in the central tube it seals it and it acts as a siphon. The acetylene continues to go through to the burner by the exterior tube, e, and by the little holes, x, y, z, by which the exterior tube communicates with the interior tube, a. As this siphon action is continuous, the interior tube carries off constantly the condensed vapor of water into the recipient whence it came. Furthermore, a disk, c, of large area, soldered to the tube, a, just above its lower opening, condenses the first vapor carried off by the gas. Furthermore, it enables one to withdraw this tube to get access to the entire system for cleaning and drying it.

It is very important to be able to govern the production of acetylene, because if the basket contains a large quantity of calcium carbide, the production of the gas would become more and more rapid. In spite of the regulation by successive immersions, the vapor of water traversing the calcium carbide from below upward finally moistens the whole mass. To govern adequately the production, Mr. Trouvé has adopted a system of superimposing the lumps of carbide in layers separated from each other by disks of glass. These act as diaphragms to prevent the vapor of water carried off by the gas from traversing the carbide which they support, and the automatic production of the acetylene is uniform from the beginning to the end of the lighting. First the lower layer is reduced to lime, then, as it softens, the second layer, descending, takes its place, and this action is repeated with the successive layers until the carbide is completely exhausted and the disks of glass rest one upon the other on the bottom of the basket.

Acetylene having almost the density of air, 0·92, burns best in a still atmosphere, so that the burner is placed in the center of the metallic disk, which tends to deprive the air of any upward draught, giving the flame proper steadiness. These lamps consume on an average 1,543 grains (about 3¼ ounces) of carbide for 38 candle hours.

The next two illustrations, Figs. 6 and 7, represent the Fuller acetylene generator shown in use for scientific purposes. The generator, constructed largely on the principle of the Dabereiner lamp, is shown in the cuts, standing on the floor. The outer vessel is a tank containing water and provided with a concentric core to reduce the quantity of water required to fill it. In this tank of water is inverted a gas holder bell, whose top in the cuts is seen projecting above the tank. In the projecting top is inserted a second small bell of metal, which is made gastight in its position by a water seal. This bell carries a suitable basket for holding carbide of calcium, and the proportions of the apparatus are such that when the gas holder is immersed in the tank, the latter containing the proper quantity of water, the carbide basket will be under water. If charged with carbide, gas will be rapidly generated, causing an increase of pressure within the bell or holder, with consequent depression of water. This depression causes the water to leave the carbide, and generation of gas ceases. Should this depression be insufficient to provide for the gases generated, the holder itself will rise until something like a cubic foot of gas will be accumulated. On the other hand, if the gas is drawn off, the pressure will fail, water will again rise and come in contact with the carbide, again generating gas.

Referring to the cuts, a small tank or vessel is seen attached to the side of the tank. This is a simple surface condenser cooled by water, the purpose of which condenser is to remove water from the gas in order that it shall be dry. Moreover, the gas, as will be seen, is collected from the very top of the bell. In rising to this point it comes to a certain extent in contact with the upper layers of the carbide, which in their turn act as a very efficient drier. Thus the gas

is delivered in the best possible condition to the burners.

One of the cuts, Fig. 6, shows the apparatus in use for microscopic and reading purposes, the same generator supplying a special burner for the microscope and a standard reading light. Another cut, Fig. 7, shows a four flame burner for a magic lantern. In order to give the construction adopted, the burner is shown standing on the table and drawn back from its position in the body of the lantern.

This apparatus is the invention of Mr. H. F. Fuller, M.A., F.F.S.C., a well known scientific authority identified with the construction of apparatus of demonstration for many years. It is being manufactured by the Walmsley, Fuller & Company, 134 Wabash Ave., Chicago, Ill.

In the larger form of apparatus it is proposed to have the surface condenser supplied by a constant stream of water to condense the steam from the gas. In the smaller type of apparatus here shown this is found to be quite unnecessary.

STRENGTH OF EUROPEAN ARMIES.

COL. H. J. T. HILDYARD, commandant of the English Staff College, has, in accordance with custom in recent years, prepared for the Council of the Royal United Service Institution a précis of the annual reports compiled by Von Lobel on the changes and progress in military matters in 1894, which is published in the current issue of the Journal of the Institution. The estimated forces are as follows:

Austria-Hungary, available in first and second lines, but exclusive of the Landsturm formations, is, in round numbers, as follows: 1,711,220 officers and men, 193,345 horses and 2,024 guns. Of Belgium: Field army, 72,932 men; fortress troops, 58,380; total, 131,312.

Bulgaria and East Roumania.—The entire war strength, field army, reserve army and Landsturm, is estimated in round numbers to be 257,000 men, 38,500 horses and oxen, 9,000 wagons, 180,000 bayonets, 7,000 sabers and 420 guns. In order to supply as a temporary measure the want of trains, every parish is under the obligation of keeping always ready a wagon of a prescribed pattern and a pair of horses. In this manner at the present time there are in each provisional district from 150 to 180 of these wagons in good condition, making over 1,000 for the whole army.

Denmark.—The war strength is 1,185 officers and 42,903 men. In addition to these there would be available for reinforcement 245 officers and 13,720 men.

England.—The present strength of the British army was given in the Journal of January 11, p. 324.

France.—The important changes effected in the French army in 1894 comprise the new organization of the field artillery and the simultaneous addition to it of twenty-eight batteries, the abolition of the regiments of pontooners, the duties of which are transferred to the engineers, and the issue of new drill regulations for the infantry. The number of recruits on the muster roll for 1893 was 343,651—66,226 more than in the previous year. Deductions had to be made from this number of 30,356 who were declared to be unfit for service, and of 10,784 who did not appear at the muster. Allowing for some minor deductions, the contingent finally approved numbered 212,700 men. There were further 25,627 men voluntarily enlisted for the army in France, Algeria and elsewhere, which makes a total of 238,327. An instruction published in May, 1894, has replaced the regulations in force since 1890 for the supply of small arm ammunition in the field. The total number of rounds to be carried per man is 303, distributed as follows: Carried by the soldier, 120 rounds; in the company wagons, 65 rounds per man; in the infantry, ammunition and park sections, 118 rounds per man. The changes made in the former regulations were due to the abolition of the previously existing battalion small arm ammunition wagons, and the substitution for them of company wagons, in the proportion of one per company. These follow the troops, and on the adoption of fighting formation the cartridges are issued to the men, and the wagons assembled behind the reserve of the regiment. During the engagement, if the necessity arises, an ammunition wagon with small arm ammunition is detached from the infantry ammunition section to each battilion. The carrying into the fighting line of the ammunition from these wagons is done by men detailed from the reserve.

Germany.—The total establishment is set down as 18,699 officers, 528,167 of other ranks, 95,794 horses, 2,542 horsed guns, and 97 horsed ammunition wagons. For the whole of Germany the number on the alphabetical and postponed lists for service for the year 1892-93 was 1,522,076, from which it appears that the fear expressed at the time of the discussion on the increase of the army in 1893, that the men required to complete the larger annual contingent would not be forthcoming, was unfounded.

Italy.—At the beginning of 1894 the available strength of the Italian army was 3,333,682 men. At the end of the year a number of royal decrees were promulgated, having for their object to effect economies in the budget by doing away with all appointments and formations which can be dispensed with in peace time, while in war they would be superfluous. Altogether, when the full effect of the new regulations is felt, the number of officers will be more than 900 less than previously, and that of civilian officials in military employ 400 less.

Japan.—The reorganization of the army of Japan after the European pattern dates only from 1872. The results attained are somewhat remarkable, looking to the comparatively short time that has since elapsed. The organization of the army in peace is in seven divisions, one of which is composed of guard troops. The same organization was assigned for war; but on the occasion of the mobilization for the war against China an army corps organization was adopted. The constitution of the Japanese division follows closely that of European armies, and numbers about 12,000 combatants in war—in peace only between 7,000 and 8,000. There are, however, great possibilities for expansion of the army, as the population of the territorial districts from which the annual contingents are drawn is exceedingly dense. Japan has taken care to defend the capital by fortifications, to maintain communication between the several portions of her territory that are separated by the sea, and to close the Straits of Corea. The fortifications answer modern requirements. Armor has not, however, been utilized in their construction.

Montenegro.—Excepting two companies and a mounted bodyguard for duty at the court, and 500 to 600 men on the frontier, no service is given in Montenegro in time of peace. The total strength of the army is, however, about 50,000 men—that is, 25 per cent. of the population. From past experience it would seem likely that the whole available force could be assembled within a week either on the Austrian or Turkish frontier.

Netherlands.—The strength of the field army should be: 1. Combatants: 696 officers, 34,867 other ranks, 3,184 horses and 120 guns. 2. Non-combatants: 174 officers, 3,471 other ranks, 2,574 horses and 459 wagons. The garrison troops number 360 officers, 16,734 other ranks.

Roumania.—The peace strength is 44,721 men and 9,584 horses. To be added to these are those men not embodied for permanent service, but called up annually for limited periods of training, namely, 65,726 infantry and 8,866 cavalry. In all the circumstances it seems probable that the mobilization of the field army would be completed within about fifteen days.

Russia.—The peace strength of the Russian army in Europe and the Caucasus, exclusive of local instructional troops, frontier guards, gendarmerie and smaller units, in 1894, was approximately about 749,640 men, with 1,744 guns. On mobilization for war, not including the local commands and the Caucasian militia, the numbers available are estimated as 58,330 officers and 3,077,394 men. The regular infantry and artillery are recruited exclusively from Europe, and it is not possible to say with certainty how far the force is in a position to be placed complete on a war footing. According to Russian sources, including the troops quartered in the Irkutsk military district, there can be assembled in the Amur territory 30,000 infantry, 5,000 cavalry, 1,600 artillery and 82 guns.

Spain.—The mobilized forces are estimated to amount to 176,035, exclusive of officers, with 590 guns. Of reserve troops there are estimated as available 5,500 officers and 585,000 men of the First Reserve and 1,217,000 of the Second Reserve.

Switzerland.—The forces that would become available on mobilization in Switzerland are divided into three categories. The first comprises all able-bodied men between the ages of twenty and thirty-two, the second those between thirty-three and forty, the third all others between the ages of seventeen and fifty. On January 1, 1894, the first category (Auszug) comprised 97,929 infantry, 3,344 cavalry, 20,294 artillery and train, and 6,792 engineers and auxiliary services. The second category (Landwehr) was made up of 57,979 infantry, 2,936 cavalry, 12,357 artillery and train, and 3,236 engineers and auxiliary services. In the third category (Landsturm) the strength available is 53,981 fusiliers, 4,672 rifles, 3,206 artillery of position, 115,958 pioneers and 97,479 auxiliary services. From the paper strength of the forces given here it would probably be necessary to deduct at least 20 per cent. to obtain the marching-out strength.

Turkey.—The total peace strength of the army and establishments of Turkey is from 222,000 to 225,000 men, but of this number only from 170,000 to 175,000 are included in the strength of the combatant formations. According to the estimate given in the reports for 1892, it is probable, looking to the actual conditions, that for a great defensive war, Turkey could, within the space of two to three months, commence a campaign with about 400,000 men. In the case of a protracted war it might be possible for her to dispose, from first to last, of another 400,000 men.—Army and Navy Journal.

SELECTED FORMULÆ.

A New Coloring for Ironwork.—A suitable medium for coloring iron and steel a dead black may, it is said, be produced by mixing together 1 part of bismuth chloride, 2 parts of mercuric chloride, 1 part of copper chloride, 6 parts of hydrochloric acid, 5 parts of alcohol and 50 parts of water. In order to secure the most satisfactory results—the article to be treated being first made clean in every respect, and free from grease—the preparation is applied with a swab or brush, or, better still, the object may be dipped into it, the liquid being allowed to dry on the metal, and the latter is then placed in boiling water and the temperature maintained for half an hour. If after this the color is not so dark as may be desired, the operation is simply repeated, the required density being thus easily attained, and, after obtaining the desired degree of color, the latter is fixed as well as improved generally by placing for a few moments in a bath of boiling oil and heating the object until the oil is completely driven off.—Iron and Coal Trades Review.

Reid's Antiseptic Liquid Dentifrice.—

Thymol	2 grains.
Carbolic acid	5 drops.
Oil eucalyptus	3 "
Oil calamus	5 "
Oil sassafras	8 "
Oil wintergreen	8 "
Oil rosegeranium (Turk)	8 "
Oil pinus pumilio	20 "
Soap, white castile	2 drachms.
Glycerine	2 oz.
Alcohol	4½ "
Water	enough to make 16 "
Tincture cudbear,	
Caramel, of each sufficient to color.	

Dissolve the soap in 5 ounces of warm water. Dissolve the carbolic acid and oils in the alcohol and add to the soap solution. Filter through paper, using pulp or calcium phosphate to clarify. Lastly, incorporate the glycerine and coloring.—Pharmaceutical Era.

Gloss for Linoleum or Oilcloth.—1. Wash with a large, soft woolen cloth and lukewarm or cold water, dry thoroughly with a soft cloth, and afterward polish with milk, or a weak solution of beeswax in spirits of turpentine. Never use a brush or hot water, or soap, as either will be apt to bring off the paint. 2. Wash once a month in skim milk and water, equal quantities of each. Rub them once in three months with boiled linseed oil. Put on a very little and rub it well in with a rag, and polish with a piece of old silk.

Cleaning Rusty Instruments.—Brodie gives the following as an effective method of cleaning rusty instruments (Jour. Brit. Dent. Assoc.): "Fill a suitable vessel with a saturated solution of stannous chloride in distilled water. Immerse the rusty instruments and let them remain overnight. Rub dry with chamois after rinsing in running water, and they will be of a bright silvery whiteness."—Clinique.

For Frost Bite.—In the treatment of frost bite, Boeck (Monatshefte f. Praktische Dermatologie, in Med. News) recommends the following formula:

Take—Ichthyol, Resorcin, Tannic acid,	of each 1.00.	
Water,	5.00.	Mix.

Apply with a brush at night.

Should this for some reason or other be objectionable, the following formula may be substituted:

Take—Resorcin,	2.00.	
Mucilage of gum arabic, Water,	each 5.00.	
Powdered talc,	1.00.	Mix.

Apply topically with a brush.

Soldering Glass.—Recent investigations pursued by Margot have established the interesting fact that an alloy composed of ninety-five parts of tin and five of zinc melts at 200° C., and becomes firmly adherent to glass, and, moreover, is unalterable and exhibits a most attractive metallic luster. He has further ascertained by this experiment that an alloy consisting of ninety parts of tin and ten of aluminum melts at 390° C., becomes strongly soldered to glass, and is possessed of a very stable brilliancy. With these two alloys, it is possible, it is claimed, to solder glass as easily as it is to solder two pieces of metal, and this operation may be done by soldering the pieces of glass, when heated in a furnace, by rubbing their surface with a rod of the solder, the alloy as it flows being evenly distributed with a tampon of paper or a strip of aluminum—or an ordinary soldering iron can be used for melting the solder.

Preparation of Caramel.—Dissolve 7 lb. of crushed sugar in 1 pt. of water; boil it in a 5 gal. copper kettle, stirring occasionally until it gets brown; then reduce the fire and let the sugar burn "until the smoke makes the eyes water." When a few drops, let fall into a tumbler of cold water, sink to the bottom and harden sufficientiy to crack, it is done. Then pour on it, by degrees, about 2 qt. of warm water, stirring all the time. When well mixed, filter it hot through a coarse flannel filter. Some use lime water to dissolve the burnt sugar. Care must be taken not to overburn it, as a greater quantity is thereby rendered insoluble. The heat should not exceed 221° C. nor be under 204° C.

Fertilizer for Pot Plants.—The following has been recommended very highly for fertilizing pot plants:

Ammonium nitrate	30 g.
Ammonium phosphate	25 "
Potassium nitrate	45 "

Use 1 part of this mixture for each 600 parts of earth.

Pill Coating with Paraffin.—C. De Houck finds that pills can easily be coated with paraffin by heating them to about 80° C. in a capsule and adding the paraffin in shavings and rotating; 2 or 3 grammes of paraffin are sufficient to coat 1,000 pills. The coating in no way interferes with the action of the pills, since they disintegrate easily in the mouth.—Annales de Pharm., ii, 66.

Sticky Fly Paper.—

(1)	Resin	9 parts.
	Rape seed oil	4 "
(2)	Resin	8 parts.
	Turpentine	4 "
	Rape seed oil	4 "
	Honey	½ "
(3)	Resin	1 pound.
	Molasses	3½ ounces.
	Linseed oil	3½ "
(4)	White resin	1 pound.
	Castor oil	8 ounces.
(5)	Gumthus	4 ounces.
	Linseed oil	1½ "
	Honey	1 "

The ingredients in any one of the above formulæ should be thoroughly mixed by heating over a gentle fire with constant stirring, and the mixture applied warm to sized paper by means of a flat brush.

Paper may be sized by coating with a solution of ordinary glue or with flour paste made by dissolving one pound of wheat flour in one gallon of water.

Large manufacturers have special machinery for making fly paper on a large scale.

Artificial Cider.—

Filtered water	20 gallons.
Moist sugar	12 pounds.
Tartaric acid	½ "
Rectified alcohol	3 pints.
Elder and melilot flowers, of each	4 ounces.

When the fermentation is finished, it should be placed in a cool cellar and left to repose for ten days, then fine with isinglass and bottle; the bottles should be kept lying down.

To Restore Insoluble Bleached Shellac.—Bleached shellac, particularly when overtreated with chlorine, is apt to become insoluble in alcohol, and hitherto no treatment for its restoration was known. It has now been discovered that if such insoluble shellac is first moistened with one-twentieth of its weight of ether, and allowed to swell in a closed vessel, its solubility in alcohol will be restored.—Western Druggist.

ENGINEERING NOTES.

A sensitized paper for making engineering reprints, which does not necessitate making a tracing of the original, is highly commended by Engineering. The reprints consist either of white lines on a dark brown or brown-black base, or, if desired, may be brown-black lines on a white base.

The Ferris Wheel, which was one of the great attractions at the Columbian Exposition, has been removed from its original site in the Midway Plaisance and has been reconstructed with improvements on North Clark Street, near the northern end of Lincoln Park. Some new features have been added, such as buffet and tally-ho cars.

The following is a list of some of the great steam hammers in European iron works: Terni Works, Italy, 50 ton hammer, made in 1873; Alexandrovski, Russia, one of the same weight, 1874; Creusot, France, 80 ton hammer, made in 1877; Cockerill Works, Belgium, one of 100 tons, made in 1886; one at the Krupp Gun Works, Essen, Germany, also made in 1886, weighs 150 tons and is probably the heaviest in the world.

The soot ejected by a smoke stack weighs more than is commonly supposed. The stack of a German sugar factory has been provided with a soot catcher. Six days afterward the soot was removed, and it was found that during the time 6,700 pounds had accumulated. The stack of such a factory is estimated to throw out during the period of the year during which it is in operation the enormous quantity of 200 tons of soot.

The Association of American Steel Manufacturers is moving to secure the adoption of standard structural shapes throughout the country. This will simplify and cheapen the production of structural steel; and it will also result in economy in time and labor in constructional work. The Carnegie Works are now rolling no less than fifty-six different sizes of angles. If the proposed standard be accepted, this number will be reduced to less than twenty.

Indian Engineering recently published an article describing a project for a transcontinental route to the East across Arabia, whereby communication with India would be facilitated, and which, if carried out, would produce almost as great a revolution in the commerce of the East as did the opening of the Suez Canal. The article is illustrated by a chart showing the route of the proposed line. This great mercantile artery to the East would, it is calculated, cost about $750,000,000.

The Pennsylvania.—It has transpired that the large steamship on the stocks in Messrs. Harland & Wolff's for the Hamburg American Company is to be called the Pennsylvania. In point of size it will eclipse anything now afloat. The length of the vessel will be 560 ft., the beam 63 ft., and the depth 42 ft. The displacement tonnage will be 20,000 tons. There will be 30,000 tons of cargo capacity, and accommodation for 1,500 steerage and 300 saloon passengers. The Pennsylvania will be ready early next year.—Marine Engineer.

In September, 1895, a congress was held at Zurich to agree upon methods for the examination of building materials. The meeting seems to have confined itself simply to metals, though stone, cements, timber, paper and protective coatings, each require separate study. A number of architects, engineers and builders were present from Germany, Austria, France and Russia. Belgium, Britain and America were scarcely represented. An international association for the assay of building materials was organized. A congress will be held at Stockholm in the year 1897.

An American firm of contractors has just completed a 50 mile extension of the Jamaica Railroad, in the island of that name, which has taken five years to build, on account of extraordinary natural obstacles. It runs from Kingston over and around the Blue Mountains to Port Antonio, on the east coast, with mountain or morass all the way, says the Railway Age. It has 27 tunnels, 193 girder bridges, 13 viaducts and 11 tower bridges, and the cost of the work is said to average over $100,000 per mile. The extension, it is stated, opens "a magnificent fruit region, where oranges, bananas, pineapples and limes grow in luxuriant abundance, and where the finest logwoods are found."

Japanese Pig Iron.—A sample of iron which had been made from native ore and coke at the Japanese furnaces was recently exhibited at Middlesborough, England. It was brought to London as ballast, and the price delivered, which was about $9 per ton, may be taken as about the cost of production. It was pronounced to be of good quality, and it showed the following results when analyzed in comparison with Cleveland pig iron:

	Japan Pig. P.C.	Cleveland Pig. P.C.
Silicon	3·26	2·80
Sulphur	0·38	0·04
Phosphorus	0·81	1·46
Manganese	1·44	0·52

Mr. H. H. Campbell recently read a paper before the American Society of Civil Engineers on the qualities of acid open hearth nickel steel. For the special purpose of securing a reliable test, the Pennsylvania Steel Company made a heat of nickel steel and rolled it into common structural shapes. It also made similar shapes of low phosphorous acid open hearth without nickel. A third grade of steel without nickel was also tested. The results were as follows:

	Tensile Strength.	Elastic Limit.	Elongation in 8 in.	Reduction of Area.
Nickel steel	84,377 lb.	56,760 lb.	17·13 p. c.	43·4 p. c.
Carbon steel	84,327 lb.	*50,000 lb.	21·71 p. c.	41·3 p. c.
Carbon steel	78,918 lb.	49,128 lb.	23·06 p. c.	50·8 p. c.

*Approximate.

Mr. Campbell considered that the results fail to verify the supposed superiority of nickel over other kinds of steel. Any superiority it possesses is not so marked that its use in ordinary engineering work is likely to be profitable.

ELECTRICAL NOTES.

A plant for the manufacture of chlorate of potash by the action of the direct electric current upon a solution of potassium chloride is being erected at Niagara Falls.

The electrical fan, which has proved such a boon when the thermometer is up in the nineties, is being put to useful service when the temperature is near the zero mark. It is found that by keeping the air in a store in constant circulation by the fans, the windows can be prevented from becoming frosted.

Mr. Hutchinson recently gave, before the American Institute of Electrical Engineers, the results of a series of tests which he had made on the Sprague electric elevators in the Postal Telegraph Building, New York. The total distance traveled by the six cars during the tests was 67·11 miles, the corresponding kilowatt hours being 290·3, or 4·33 kilowatt hours to the mile.

The Atlantic cable was put to a novel use recently when eight American and eight English chess players sat down at either end of it for an international game. The game was watched by enthusiastic audiences, for whose benefit eight large chess boards were exhibited, duly ticketed with the names of the respective players, the moves being recorded as they were telegraphed from either side of the Atlantic.

The application of electricity to the Harrington portable hoist shows one of the latest developments in the application of electricity to hoisting machinery. Its capacity is ten thousand pounds, which load it can raise at a maximum speed of 5¼ feet per minute, and lower at the rate of 10 feet per minute. By means of a controller, operated by a rope, the speed of the motor may be varied indefinitely within these limits.

One of the latest methods of conduit wiring for railway cars consists of the use of insulated waterproof and fireproof tubes, which are concealed in the framework of the cars. The tubes are run from the roof to the motors, controllers, etc., and form a complete insulated system. The wires are at all times accessible, and defective wires can be withdrawn and new wires substituted without defacing the woodwork of the car.

A committee composed of representatives from all the leading insurance and engineering associations, and from the chief manufacturing establishments, is about to undertake the task of drawing up a set of standard rules for electrical construction and operation. As the committee will represent the highest professional talent of the day, its recommendations will have a proportionate value and should result in the saving of much time and labor.

There is a growing tendency in England toward municipal ownership of new electrical installments. The London correspondent of the Electric Railway Gazette states that, in towns which have at present neither electric lighting, electric railways nor refuse-disposal system, there is a move in favor of the consolidation of the three ventures in one plant, dust destructors being considered in some quarters an economical method of generating heat for steam purposes, though they are viewed with reserve by some practical men.

The recent effort of a New York paper to ascertain by telegram the willingness of the banks of the United States to subscribe to the new government bond issue develops some remarkable feats of telegraphic dispatch The first batch of messages, 3,698 in all, was sent out on Sunday night, January 5. These messages were received by the Western Union Telegraph Company at the main office at 6 o'clock, and were all sent out before midnight. The second lot of messages, to the number of 6,672, was sent out a few nights later, the transmission lasting eight hours, from 6 P. M. to 2 A. M.

The Railroad Society of Berlin was recently addressed by Mr. Leissner on the question of electric traction on trunk lines. His paper was pessimistic as regards immediate developments. "The hopes of attaining unusually high speeds are shattered, and several projects have fallen flat, because existing railroad lines are not adapted for operation at speeds of 150 miles per hour. . . . Our generation will not see such schemes revived. . . . The great first cost of the many power stations, needed for long lines with dense service, will prevent a change of motive power at the present state of the electric art."

World's Telegraph Lines.—A German investigator has announced, says Bradstreet's, that the total length of telegraph lines in the world is 1,062,700 miles, of which America has 545,600 miles; Europe, 380,700; Asia, 67,400; Africa, 21,500; and Australia, 47,500 miles. The United States has a greater length than any other country, 403,900 miles, and Russia comes next, although European Russia has only 81,000 miles. The other countries follow in this order: Germany, France, Austria-Hungary, British India, Mexico, the United Kindom, Canada, Italy, Turkey, the Argentine Republic, Spain and Chile. In point of proportion, however, Belgium leads with 409 miles of wire for every 1,000 square miles of territory; Germany comes next, with 250 miles; Holland is only slightly behind Germany, and the United Kingdom has 280 miles of telegraph for every 1,000 miles of country.

Mr. Maurice Barnett is of the opinion that the field of usefulness of the storage battery will be more extended as its construction and manipulation become better understood. He sums up the various uses to which it will be applied as follows: "(1) As a 'reservoir' in which may be stored up the energy representing the difference between the average and the maximum demand on a generating plant; (2) as a regulator of pressure on circuits subject to fluctuating demands—increasing the efficiency of the service and diminishing the wear and tear on apparatus; and, (3) as a transformer, to utilize a charging current at high voltage, and to discharge, when disconnected from generator, at any lower voltage desired." He further states that "it has been demonstrated that for any station which has to meet a fluctuating demand for power, a plant consisting of part steam power and part storage battery is cheaper in first cost than a total steam power plant would be for the same work."

MISCELLANEOUS NOTES.

It is claimed by a lumber journal that there are 197,146,420 acres of timber lands in the Southern States, and that the average yield of these forests is 3,000 feet per acre. Most of this is found in the Mississippi valley.

The great bore hole at Paruschowitz, in Upper Silesia, the deepest in the world, has been sunk to a depth of 6,570 feet. It passes through 80 coal seams, whose total thickness is 293 feet. The temperature increased one degree Centigrade for every 111 feet of depth. The weight of the rod, tools, etc., was 14 tons. The boring progressed at the rate of 16 feet a day, and the total cost was $15,045.

There is a movement on foot for the establishment in New York City of a historical museum where persons or organizations can deposit with perfect safety, either permanently or as temporary loans, valuable relics of revolutionary or colonial times. This will be virtually a safe deposit vault open to the public, so that all may enjoy the mass of documents and relics now extant, but inaccessible to the public. Much of this is now in peril of destruction.

The analysis of earths from various places in the Lower Congo district proves that the soils there, sandy as well as calcareous, are provided with reserves of phosphoric acid and potash, which insure a high fertility. It is regarded as certain that, in the territories where the disappearance of forests has not modified the rainfall, the cultivation of coffee, cocoa and other economic plants can be carried on for a long time without the use of manure.

The phenomenally high barometrical readings of January last were discussed at the Meteorological Society's meeting on February 19, when it was stated that readings of over 31 inches were recorded on January 8. These were the highest recorded readings in the British Islands, the maximum being reached at Glasgow, where the barometer stood a 31·119 inches on January 9. The highest recorded reading in the world occurred at Barnaoul, in Siberia, in 1877, where a reading of 31·62 inches was taken.

M. Charles Margot, professor of physics at Geneva, has succeeded in electroplating aluminum with copper. His method consists in first cleaning the aluminum with an alkaline carbonate, after which it is thoroughly washed in running water. This is followed by an immersion in a five per cent. solution of hydrochloric acid and another washing in pure water. A preliminary deposit of copper is then obtained by immersing the article in a weak and slightly acid solution of sulphate of copper. This done, the article is thoroughly washed and placed in the electrolytic bath.—Engineering.

It appears that the popular belief that water taken from deep wells will be found to be free from bacteria is not well founded. The bacteriologist of the Massachusetts State Board has recently shown that "bacteria exist not only in water taken from springs and open wells, but in water taken from carefully guarded wells of quite extraordinary depth." It should be noted, however, that the report says: "It is difficult to find deep wells in uninhabited or country districts, and our results are all derived from populous areas. It is possible that other results might be obtained from wells driven in uninhabited regions."

It looks probable that before long the Dominion government will establish the long talked of line of fast steamers between the St. Lawrence and a British port. The vessels are not to be inferior to the Teutonic of the White Star line in general equipment and with a capacity for between 400 and 500 cabin and 1,000 steerage passengers. In regard to speed, they will be required to make 21 knots in a 6 hour trial run and to be capable of ordinary ocean steaming at 20 knots an hour. They will be of not less than 8,500 tons. The Canadian government will give a subsidy of $750,000 a year, which the British government will supplement by an annual subvention of $350,000.

In one of his latest public utterances Gen. Sheridan declared that the improvements in guns and other weapons were tending to make war so destructive and terrible that some substitute for it was rapidly becoming a necessity, and the only available substitute, he added, was arbitration. Gen. Grant was a strong advocate of arbitration, and on one occasion said: "Though I have been trained as a soldier and have participated in many battles, there never was a time when, in my opinion, some way could not have been found of preventing the drawing of the sword. I look forward to an epoch when a court recognized by all nations will settle international differences instead of having large standing armies as they do in Europe."

The Miller (English) says: The population of this kingdom in the sea (British Isles) is nearly 50 per cent. larger than in 1855, and it closely approaches to that of France. The area under wheat and the product thereof are about one-third of the total of 40 years ago, while the importation of wheat and flour has increased nearly eightfold, and the fact stands revealed that this country does not produce 25 per cent. of her bread wants.

	Population British Isles.	Area under wheat, acres.	Yield of wheat, allowing for seed.	Imports of wheat and flour.
1855	27,750,000	4,080,000	12,750,000	3,250,000
1895	39,500,000	1,460,000	4,250,000	25,000,000

By far the largest combination of trade interests ever formed on the Pacific coast is that known as the Central Lumber Company of California. It represents nearly $70,000,000 of capital. All charters of vessels and sales of lumber must be effected through this company, which regulates freights and puts the buying and selling price on lumber, regulating also the product of each mill and proportionate amount of lumber each vessel shall carry. Not only are the markets of the Pacific coast thus controlled, but lumber shipments to foreign countries are placed under the same restrictions. Every mill on the coast has its product regulated. The first order issued by the company was an advance in the price of lumber $2 a thousand, which will mean an increase in profits of many thousands of dollars during the coming year.

THE PORCELAIN WORKS AT MEISSEN.

THE future belongs to the artistic trades. In these times, when all thirst for beauty, people are no longer content to enjoy art in museums. The home, which must be made as luxurious as possible, opens its doors to it. All porcelain was formerly brought from China and Japan, but it has always been most highly prized by the polite world. The oldest and best known factory for this branch of ceramic art is the imperial porcelain factory, near Meissen, Saxony, from which the world renowned "vieux Saxe" came, and which now places on the market many real masterpieces, some of which are made after old models, while others bear the stamp of the latest and most modern taste. These artistic works are open for inspection to any visitor upon the payment of the sum of one mark for a guide, and a tour through the factory is highly interesting and instructive. One looks with entirely different eyes on the objects of art in the stores after he has seen the details of manufacture and realizes the number of hands through which each article must pass before it is complete. After entering the great square building, with numerous wings, which constitutes the factory, we are conducted across a wide court, in which lie piles of the materials from which the porcelain paste is prepared—kaolin or porcelain clay, which is obtained partly from underground pits and partly from open pits in the Saxon villages of Seilitz and Sornzig, and feldspar, most of which is brought from Norway. The first room we enter is the washing room, in which the porcelain clay receives its first treatment, which consists of a cleaning process, during which, after leaving the washing apparatus, it must run through a series of vats and channels in which the heavier substances mixed with the clay are precipitated. Then the clay is mixed with the feldspar and quartz, which have previously been separated from all impurities by means of the hammer. The mixed mass is passed to the filter presses and then to the kneading machines, in which it is uniformly blended and freed from all air bubbles. It is then rammed into casks and stored for some time, to give it plasticity and render it more suitable for working. In China the mass is stored for two or three years, but in Meissen ten months is considered sufficient. This storing is most important. There are still supplies of the oldest porcelain clay found near Aue, in the Erzgebirge, which gives a reddish tone to the paste; it is used for particularly delicate figures.

With the mass that has been thus treated we come to the moulding room, where human hands and machines vie with one another in giving it form. The most important part of the work done here is that of the modeler, who produces first the clay model and then the plaster mould; later the bosser puts the finishing touches on the article, correcting all faults in the plastic decoration. All of this must be done in the most artistic manner and with a thorough knowledge of the material used, so that there shall be no clumsiness. Near these are turners who form the articles that are not formed by machine, and those which are thus turned are afterward pressed in plaster moulds to give them regularity of shape. Sometimes figures and groups are moulded in separate parts that are then fastened together, according to the model, by

IN THE LABORATORY.

TURNER.

PUTTING ON THE GLAZE.

means of the thinned paste or "slip." Handles, relief flowers, and other ornaments, are formed and put on in the same way. The porous plaster of the moulds sucks up all moisture, leaving the moulded objects quite dry. The perforated decorations are cut out with a knife. The delicate lace trimming on many little rococo figures is made in the following manner: Tiny rods, of which the lace or tule insertion is made, are formed of the slip by means of a brush and then

THE MODELING ROOM.

A CARRIER.

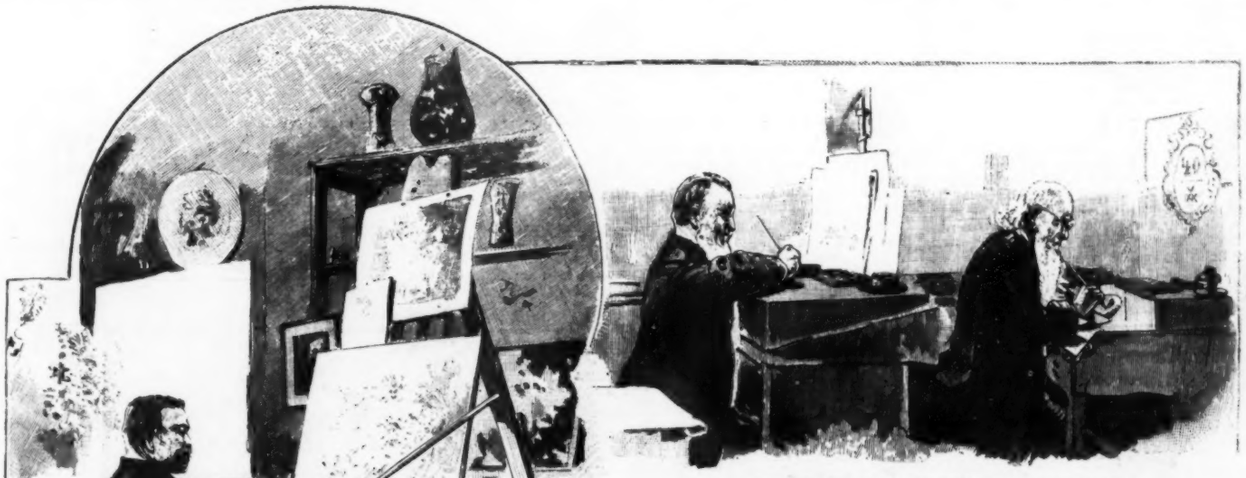
united. This process is a trial of patience, and requires the painstaking care of women's hands.

Although spotless white is most suitable for many classic figures, a great charm of this branch of art is the polychrome work, and the Meissen works are specially noted for their wonderful color effects on the brilliant porcelain. They make their own colors, and we will inspect a large chemical laboratory where, although gold is not made as in Böttger's time, many gold tints are discovered. Lately special attention has been paid to increasing the scale—already quite long—of colors that will stand very strong heat, a distinction being made between the colors used in underglaze painting and those employed in painting on the glaze. Many charming color effects can be obtained by this latter process, but the work is more easily damaged, as is often quite noticeable in table ware, and for this reason it is very important that such articles should be painted under the glaze, and during the baking the colors blend with the glaze, and cannot be injured. Until lately the only colors that were known to be capable of withstanding the heat were oxide of cobalt for blue, oxide of chromium for green, and oxide of uranium with oxide of cobalt for black, but now other oxides are used, such, for instance, as oxide of iridium, copper, etc.

We have already referred to the glaze, but now let us go to the glazing room. The articles made from the paste as above described are subjected to the first baking; that is, they are exposed to a temperature of from 1,400° F. to 1,800° F., which hardens them, and leaves them porous and very brittle. Then they are ready to be painted with the fire colors or finished as white porcelain, and for this purpose are taken to the glazing room by the carriers, who are wonderfully dexterous in balancing boards loaded with these dishes, vases, etc., on their shoulders. Here each article is dipped into the glaze bath, which consists of a milkwhite fluid composed of kaolin, quartz, feldspar and limestone. Immediately every trace of color disappears under a powdery crust, but when exposed to an intense heat, this crust fuses and the colors come out brightly. After the parts which are to remain unglazed have been carefully covered, the porcelain is ready for a second baking. The biscuit porcelain is made by exposing the unglazed articles to this second firing.

From the glazing room we are led through immense rooms containing the great circular kilns, and through the observation glasses we can see the fires. These kilns are built in three stories, the lower one being provided with six fireplaces, which, together, use on an average thirteen tons of fuel (brown coal from Bohemia). The articles in the lowest compartments of the kilns are exposed to a temperature of about 2,912° F., which is the highest degree of heat ever obtained technically. The upper compartments serve for the first baking, described above. Each separate article is placed in a sagger and these saggers are piled in columns in the kiln; the only opening is then walled up and the fire kindled. By observing the fire through the glasses, by taking our test pieces of the same material as the articles being fired, and by gas tests, the firing is regulated. The articles are first subjected to a red heat and then to a white heat, and the firing lasts from twenty to twenty-four hours. After it has been ascertained that the glaze has melted uniformly, the kiln is allowed to cool off gradually, which takes two or three days, and then the articles, which have diminished to one-sixth their original size, are taken out. The moulder and firer have done their duty and now it is the painter's turn.

The strong odor of turpentine which meets us tells us that we are approaching the painters' department. Here 360 persons are employed under the supervision of a foreman, and among them are the "blue painters," who do the greater part of their work with the help of pouncing. They paint the under glaze patterns, such as the "union pattern," the old German flowers and birds. The painting on the glaze consists of the painting of raised figures, handles, etc., and also in the painting of decorative flowers and more elaborate flower and figure painting of different styles which require more artistic education. We see great



VETERANS IN PORCELAIN PAINTING.

FLOWER PAINTER.

SEPARATING THE MATERIAL.

flower pieces made from nature by master hands that charm by the unparalleled harmony of color. These beautiful decorations stand out particularly well from a dark blue or brown background. In figure painting they are constantly returning, after more or less happy digressions, to the lovely subjects of the rococo period, which seem to be specially adapted to porcelain. Watteau, Boucher and Lancret understood, as did scarcely any who came after them, how to interpret the dainty trivialities of their time by graceful lines and most delicate coloring. Porcelain, which is adapted only for graceful forms, has found its proper decoration in the pictures of these artists. The taste of the present time shows a preference for delicate and airy coloring well suited to the spotless purity of white china. Much of the work is equal to the finest miniature painting. Admirers of the more serious style will also be satisfied, for the masterpieces of the magnificent Dresden gallery are constantly copied on vases, plaques and dishes. Copies are made of works of all kinds, from those of the celebrated Dutch artists (Dow, Metzu, Wouverman, Brouwer, Teniers) to the madonnas of Holbein and Raphael. A new and expensive kind of decoration, which is very effective, is also applied here; we refer to painting with transparent gold and platinum—the latter looks like silver—over a dark ground, which shows through in the thin places. The so-called Limoges painting, which has long been known, consists in painting with white enamel on porcelain already prepared with a dark blue ground. Mythological subjects, Cupids, etc., are specially adapted for this work. The most beautiful piece of this kind is a vase of noble antique style, about 2 ft. 3 in. high, on which Thorwaldsen's celebrated frieze—the Triumphal Procession of Alexander—is painted on a blue ground.

The Limoges work should not be confused with the pâte-sur-pâte (paste on paste) style. This latter is one of the newest methods used, for the perfection of which the Meissen works have worked zealously, and in which they are scarcely equaled by the Sevres works, which cannot produce such softness of outline in this branch of work. Here painting and sculpture go hand in hand. The slip is put on the unfired article, which has already received a ground of fire color, with a brush and modeled, by means of a brush and little pieces of wood, into bass reliefs, antique genre subjects being used mostly; then comes the firing, the glazing, and finally the second firing. The decorations lie on the tender toned ground like finely cut cameos. The use of raised and pasty colors is also new.

Burnishing is a subdivision of the painting. The gold used in the decoration looks dull and lusterless after firing and has to be burnished. This is done by women, who use precious stones (agate and bloodstone) in the operation.

At this factory they also make the colored crackle porcelain, such as formerly came only from China and Japan, and the process of making it was considered a great secret. This ware is porcelain covered on the surface with numberless small cracks, which are caused by the glaze cooling more quickly than the porcelain under it. A fluid coloring matter is brushed into these cracks and then baked in. The colors put on over the glaze are baked in the muffle of the enamel furnace with a heat of about 1470°. Artistic paintings are painted and fired over two or three times to intensify the color effects.

Our tour is ended and we now undertake an inspection of the articles for sale in the store. After having been so well instructed we even dare to criticise them. First we see a fine, life-sized bust of Bismarck, of the finest biscuit porcelain, and then we discover smaller busts of the Iron Chancellor, really fine specimens of the modeler's art. Further on the eye is delighted with the decorative ware; vases, candelabra, chandeliers and girandoles. Then we see a beautiful fireplace and even panels of porcelain for doors. The counters are laden with masterpieces of antique and modern styles, and we are surprised at the costly treasures in old models possessed by the firm. Most prominent among the oldest groups is the Parnassus group representing Apollo and the Muses, and a group doing homage to Augustus III. There are works by the master Kändler, the whole lighthearted world of the rococo and queue period; the dainty coquettes, the powdered cavaliers, the lovelorn shepherds and shepherdesses, and the little Cupids. The favorite humorous groups are Graf Brühl's tailor on the goat, and a monkeys' concert, consisting of thirty-three figures. Of course all the requirements of the different styles of art, as well as those of modern taste, are met. Electric lighting has opened a wide field for new designs for shades, etc.

All articles to be sold bear the trade marks of the concern, the best known of which is that representing the electoral sword in blue under the glaze. This is often copied more or less correctly on less valuable wares for the purpose of deceiving the public.

In closing, let us say a few words in regard to the excellent organization of the works, which endeavor to meet all practical needs by suitable improvements. They now employ about 720 workmen, 150 of whom are occupied with the technical branches. Their care for the welfare of their employes is shown by the provision of well ventilated rooms, the establishment of coffee kitchens, and a shortening of the working hours. The care of the sick and of the families of the workmen is provided for by pension funds, widows' funds, etc.

A good library is open to all. Young people are taught gratuitously in the advanced schools and drawing schools, and the most capable receive scholarships for their higher education in art schools and similar institutions, so that the Saxon institution becomes a model institution. It should also be mentioned that this factory pays to the state each year a considerable surplus, while the imperial Prussian factory, which has lately been compared with that at Meissen, and the state institutions of France, at Sevres, receive considerable assistance from their respective governments.—Illustrirte Zeitung.

TAKING TEST PIECES FROM THE FURNACE.

PAINT AS A PROTECTION FOR IRON.*

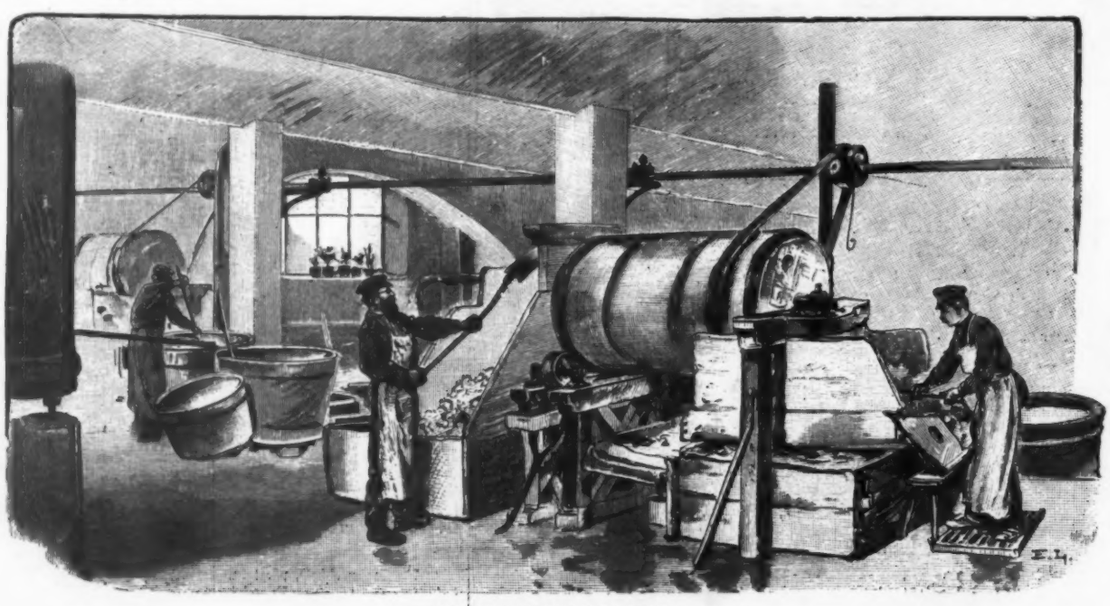
By E. A. Custer and F. P. Smith.

It would appear, from past experiments, that bright iron does not rust when exposed to a dry atmosphere of pure oxygen and carbonic acid gas, separate or mixed. After the rust has once commenced, only the slightest trace of moisture is necessary to continue this chemical action, which is probably due, not only to the corroding influence of the rust already present, but also to its power of absorbing oxygen and condensing moisture. Any covering that is absolutely impervious to moisture will, when applied to clean iron, prevent rust under atmospheric conditions in which corrosive elements are wanting. The protective covering that is to meet these conditions must be cheap and easily applied, and a paint or combination of paints seems to be the logical outcome of the problem involved.

The requisites of a good paint for the preservation of iron and steel are stated by Mr. Woodruff Jones, A.M., to be:

1st. It should firmly adhere to the surface and not chip or peel off.

* Abstracts from the Proceedings of the Engineers' Club of Philadelphia.



WASHING THE KAOLIN.

2d. It must not corrode the iron, else the remedy may only aggravate the disease.

3d. It must form a surface hard enough to resist frictional influences, yet elastic enough to conform to the expansion and contraction of the metal by heat and cold.

4th. It must be impervious to, and unaffected by, moisture, atmospheric and other influences, to which it may be exposed.

In undertaking to produce a paint with the above requirements, that would absolutely protect iron, it was early determined that the covering should consist of two distinct elements, the first of which should possess the adhesive and elastic properties, and afford a safe and elastic base for the application of a second coating that would be hard, elastic, acidproof, and absolutely impervious to moisture. There is no paint known that will meet the first requirement so fully as good red lead and linseed oil. The dry film of red lead and linseed oil, however, is porous, and this defect must be remedied by a second coating of paint, which will dry with an absolutely impervious and waterproof surface.

It has been justly claimed for red lead that the property it possesses of saponifying the oil—not oxidizing it in its true sense—renders it one of the most valuable pigments for a first coating on structural iron. After numerous experiments, a vehicle was finally selected as affording the nearest approach for an ideal outer covering for ironwork.

The pigment was next considered, and it was decided that this must itself be inert so far as iron is concerned; for while it was intended to be used over a foundation coat of red lead, it should be possible to employ it in some cases as a sole protective covering. A material was incorporated in the pigment which enables it to resist frictional action in the highest degree, makes it practically impossible to destroy, and to all intents and purposes absolutely insoluble in any of the known solvents.

One important point that must be carefully considered when the protection of iron is desired is the presence of mill scale or iron rust. No paint, however good, is worth a cent a ton for the protection of iron when used over mill scale. The absolute removal of mill scale from the iron before it is painted should therefore be specified and insisted upon. In ordinary practice it has been found sufficient to brush the surface of the iron carefully and thoroughly with a good wire brush and then apply the paint.

Attention was then called to the quality of the paint to firmly adhere to the surface of iron when subjected to very high or low temperatures, and some specimens of pipe were exhibited that were first coated when cold with the protective paint referred to, and were then subjected to live steam at a temperature of 340°, then painted while hot with the same preparation, and afterward dipped in a mixture of ice and salt until thoroughly chilled.

Mr. John C. Trautwine, Jr.: While not bearing directly upon the subject under discussion, it may be of interest for me to state that in applying asphalt paint on a concrete surface, it has been found desirable to dissolve the asphalt in a considerable proportion of benzine or gasoline; in the latter solution the best proportion being 75 per cent. of gasoline. The liquid seems to carry the particles of asphalt into the pores of the concrete, and, when it is thoroughly dry, a thicker coat of melted asphalt is applied. In this way we obtain a very perfect adhesion of the latter material.

Mr. C. D. Rinald: What Mr. Trautwine has said is true of almost all paints. Paint, for protection, should not be too heavy, as it is then much more liable to be affected by mechanical action, such as anything striking against it.

Mr. Smith: So far as the use of benzine on iron is concerned, we have found it objectionable, as it is difficult to obtain it perfectly volatile, so that when it evaporates it leaves a greasy surface, which, though not objectionable on cement or concrete, is disadvantageous upon iron.

Mr. Rinald: The use of red lead as a priming coat to make the protective coat adhere better recalls to my mind an amusing letter we received some time ago from a gentleman down South. He wrote that it was a custom in that part of the country to allow metal roofs to rust slightly, because the paint would then adhere better. Many builders, indeed, believe in allowing the iron to rust slightly, thinking that the protective paint, applied afterward, will be incorporated into the iron. I do not think that this can be proved, but I do not see why a paint cannot be made—in fact, there is a paint—that will adhere to the iron without anything under it, even when the iron is very smooth. However, a priming of red lead would certainly be better than a coat of rust.

Mr. E. A Custer: We had that experience in connection with a couple of buildings last summer. The roofs were made of tin, the front being inclined a half inch in ten feet to satisfy our city building laws. We reque ted the builder to paint it over with red lead, but he replied, "We always wait until it rusts, for then the paint sticks better."

Mr. F. Schumann: Some ten years ago we allowed a man to exhibit at our works a material that he prepared for coating iron with a glossy covering of different colors, which stood the test of being immersed in water and different acids. We bought the secret from him for the composition of the material, which was simply sandrax gum dissolved in alcohol and colored by pigments. We afterward painted a steam engine with this mixture, which, without pigment, was very transparent, so that the engine always remained clean, and prevented the iron from rusting until it was taken off, about two years after its application, at a cost of nearly $100. Why are there not some good qualities in these vegetable gums for their use in the protection of iron? It stood exposure to steam, gas and moisture.

Mr. Rinald: A similar preparation, largely used for many purposes, is gum shellac dissolved in alcohol. It makes a strong coating, but I do not think a gum will stand exposure to the weather for any length of time. It will crack and peel off.

Mr. Smith: It is, unfortunately, true of almost all vegetable gums which are completely soluble in alcohol, that while they make a good-looking appearance, they are practically worthless when exposed to the weather, and even in the better grades of varnish for wood these gums are never used for that reason.

Mr. Max Livingston: I would like to bring up the point of the comparative difficulty of protecting steel and iron. It has been my experience that paint on iron will last considerably longer than on steel, especially on the outside of steel tanks filled with water. If filled with oil, there seems to be less difficulty; but when they contain water the steel rusts very quickly. The best of paints will chip if over a steel surface, under the same atmospheric conditions where they would last on iron. I should like to know if this can be explained.

Mr. Smith: This, doubtless, is a fact; but the explanation which I must fall back upon is the somewhat lame one that some materials rust quicker than others, in the same way that some materials are more soluble in certain acids than others. Regarding bisulphate of carbon as a vehicle for paint, its fumes have a very bad effect upon workmen using it, and are probably more inflammable than the vapor of any other liquid; and I have known of cases where serious explosions occurred from paints in which it was used

Mr. Custer: I think that if the surface of either iron or steel is perfectly clean before the paint is applied, iron will not be found to last any longer than steel, so far as rust is concerned.

Mr. Schumann: The absolute removal of scale must be insisted on. We find, instead of using acid baths for this purpose, sand blasts are very efficient and very quick, and make the surface of the iron bright and clean. In the plan that I am fam liar with, a 3 × 3 angle bar 20 feet long can be thoroughly cleaned with a sand blast in about five minutes. It also has the advantage of being applicable to work already riveted together. I think it would be well if those preparing specifications should incorporate a clause requiring the cleaning of the iron and its subsequent inspection before any paint is applied.

Mr. C. E. Wolle: Resin dissolved in benzine will protect iron from the effects of salt water, as we found by experiment in shipping deck loads of this material. Regarding the rusting of tin roofs before the paint is applied, I think the tin is often exposed to the action of the atmosphere in order to allow the film of oil which covers it when manufactured to be destroyed, and the paint will then certainly adhere better.

Mr. Trautwine: In examining a piece of 6 inch water pipe laid in about 1822, we found it incrusted inside with a layer of material that proved to be chiefly oxide of iron and graphite, so that the internal area of the pipe had been reduced about 20 per cent. Another piece of 6 inch pipe laid 26 years ago, after having been first coated with a protective paint, was examined, and practically no incrustation was found upon it.

Mr. H. J. Hartley: For the last 25 years we have never allowed iron plates to be applied on ships with-

BOSSING.

MASTERPIECES.

DISCUSSION.

out first pickling them in muriatic acid, washing the acid off thoroughly, and then painting them with red lead; so that I see nothing new in that. When the ship is ready to launch, a second coat of good red lead and linseed oil is applied.

Mr. John L. Gill, Jr.: Chimney stacks made of No. 14 iron are very common on the boats sailing the Ohio and Mississippi Rivers, and are often painted with ordinary coal tar containing a little lime, to neutralize any acid that might be present. Stacks coated in this way have to be renewed about every three years. The first experience I had of red lead being used in this way was on the steamboat J. B. Williams, built during the war. Two years ago I saw this boat at Pittsburg, and it still had its original stacks, which had been protected by a coat of red lead and linseed oil applied regularly once a year. This method of protection for smoke stacks is one of the best that I know of. For boiler fronts and similar purposes I know of nothing equal to Bessemer paint.

Mr. Hartley: I think a coating of linseed oil is as good as any paint for the latter purpose.

Mr. Custer: My experience has been that on the smoke stacks of locomotives, for instance, linseed oil gummed and caused considerable trouble.

Mr. Schumann: In the discussion on this subject at our meeting of four weeks ago there seemed to be a difference of opinion as to the efficiency of a cement covering to prevent corrosion of iron. I therefore took the trouble, within the last two weeks, to inquire about this among builders who had torn down old structures built with mortar cement, and some of more recent date built with cement. Their opinions differed, but the majority seemed to be in favor of cement forming a protection for iron.

Mr. H. C. Luders: It would seem to me that the additional expense of cleaning iron in buildings would amount to almost as much as the original price of material, and if so, would it be well to insist upon the iron being so prepared by the specifications?

Mr. Schumann: I think the iron could be cleaned with sandblast at a comparatively small expense after it is placed in the structure. It would probably cost as much as handling the iron and applying the first coat of paint.

Mr. Custer: It should not matter to the designer what the expense will be, if it is made necessary in order to have a building that is absolutely safe. Any structure that is liable to break down in a few years is not worth the material in it.

[Continued from SUPPLEMENT, No. 1056, page 16882.]

MECHANICAL ROAD CARRIAGES.

By W. WORBY BEAUMONT, M. Inst. C.E.

[Cantor Lectures before the Society of Arts.*]

LECTURE III.

WHATEVER the cause of the rekindled interest in mechanical road carriages, it must be admitted that the widely spread popular feeling in their favor is due to the development which has taken place in their construction and use in France and Germany. In these countries there are several hundreds of them in use for almost every purpose. It is quite probable, however, that this fact would not have been placed prominently before the British public for some time had not the enterprising proprietors of the Petit Journal offered the substantial prizes for which several makers and many vehicles competed † in July, 1894, and in July of last year. The trials of vehicles in 1894 may be looked upon as dress rehearsals of the long journey Paris and Bordeaux trials, which took place ‡ in July of last year, and attracted, as races always do in every country, so much attention. Not only did these competitions show the practical possibility of these motor carriages for all purposes, but through them it became known in the United Kingdom that a considerable industry in their manufacture had already come into existence on the Continent. From these foreign manufacturers, two at least of these carriages were brought and used in this country so that it became obvious that a source of industrial occupation in providing a much needed means of transport was not only being neglected in this country, but was being encouraged to our disadvantage by our neighbors across the channel. The proprietors of the Engineer, seeing the possible importance of motor carriage manufacture, immediately decided to take some steps to encourage British manufacturers to occupy the field which otherwise would be left to foreign enterprise, and they, as is now well known, offered 1,000 guineas in prizes for the best motor carriages for several purposes.

It is, however, useless to build carriages which our laws will not allow us to use, and they, therefore, took steps to ascertain the feeling of the country on this subject, and to memorialize Parliament, with a view to obtaining for British engineers and motor carriage builders, and for British people, that freedom for the use of mechanically propelled vehicles which is now enjoyed by all those who use horse hauled carriages. In this work the Engineer is being supported by the Self-propelled Traffic Association, which, under the leadership of Sir David Salomon, was inaugurated recently. Steps are also being taken by influential people in several towns to secure that attention to the subject which is necessary to obtain its immediate consideration in Parliament. The Birmingham City Council, at the suggestion of Councilor R. F. Martineau, will probably present a petition to Parliament on the part of their city.

The patience of British people under legal restrictions is proverbial, and this patience has been tried to the utmost with respect to road locomotives. Much of the work of agriculture and of several other industries would now be impossible but by the aid of road locomotives, and yet, in spite of the necessity for the relief of agricultural burdens in every reasonable manner the farmer and the traction engine owner can only work these engines under restrictions and fines, and licenses and regulations which make us a laughing stock in every other country.§

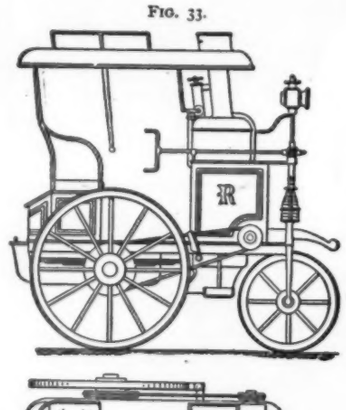
I am not, however, now concerned with these road locomotives, except in so far as the acts under which their use is regulated are the acts which prevent the use of any mechanically propelled vehicles of any kind on the thousands of miles of beautiful roads in the United Kingdom. If a man runs a tricycle with however small an electric motor for occasional assistance, he must abide by this law relating to 10 ton locomotives. The absurdity of the position is almost incredible, and surely English people need only to be reminded of it to insist upon a change consistent with prudence and common sense. I am bound to add one word more on this part of my subject. These laws, which we patiently bear, have driven from British works and British workmen the industry which now ought to be ours, but which is French and German. We could not to-day buy a British motor carriage if we would give for it its weight in gold, although it is British engineers who have shown the way to make them.

The manufacture of motor carriages may become a great industry, greater even than the cycle industry, if English people will be true to their own interests and let Parliament know that it is their will that the motor carriage shall be as free as horse carriages.

I have already shown that Englishmen, fifty-five to sixty years ago, proved with complete practical sufficiency that steam road carriages might be a commercial success. Between that time and the present, men of the United Kingdom have from time to time shown how to make steam, electrical, and oil motor carriages. They have all along been first in design and first in enterprise, but they have lived in an age and in a country which, although always grateful, prefers to postpone the recognition of genius to posthumous honor, rather than permit the most beneficial infraction of an anachronistic law. These pioneers have been, as they must be, enthusiasts on the subject, or amateurs, or both. No others would work in the development of a new thing which the laws discountenance and forbid. They generally outdistance those whom they would lead, and achieve the distinction of men ahead of time. This generally is the utmost of their consolation, but fortunately some of those who have been leaders in motor carriage construction are with us now, and we may hope they will, after all, be in at the finish.

I have time for only one or two proofs of this besides those I have already mentioned. The steam carriage shown by Fig. 33 was made by Mr. Leonard J. Todd

FIG. 33.



TODD'S STEAM CARRIAGE.

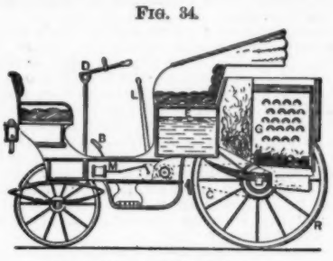
in 1870. This carriage was 8 ft. 6 in. long, 4 ft. 6 in. wide. It ran on three wheels, the drivers being 4 ft. 6 in. and the leading steering wheel 2 ft., all ordinary carriage wheels. The engine consisted of two vertical cylinders, 2½ in. diameter and 4 in. stroke, each contained in a box in front of a coal bunker on each side. They were completely protected, and each separately drove a driving wheel by means of a half inch gut belt running on a loose cone, so that the carriage could be readily steered in any direction. The steam exhaust from the two tiny cylinders was so small in quantity as to be almost inappreciable. The boiler was 16 in. diameter, 3 ft. 9 in. high, and contained a large number of Field tubes, 1 in. diameter, the heating surface being 16 ft. and the grate surface 0·75 ft. The carriage carried two persons, was a practical success, and many would have been made but for the road locomotive acts. Mr. Todd having received numerous orders and inquiries for them.

Up to this point I have not been able to speak—with the slight exception of the electrical dog cart made by Mr. Magnus Volk, of Brighton, and of the steam dog cart made by Mr. Blackburn—of Englishmen being first with reference to any but steam vehicles, but I have now to mention a vehicle with which an Englishman was first—in the construction of a motor carriage, in which an oil engine was the form of motive power used.

In about the year 1889, M. Serpollet invented the boiler known by his name. It is a capillary water tube boiler, the tubes of which were, as first made, closed up by flattening, so that there was scarcely any passage for water. The tubes were subsequently made of the crescent form (Fig. 35), and were incased in cast iron by casting them in. It is an instantaneous generation boiler, into which the feed water is forced as steam is required. The boiler was exhibited at the Paris Exhibition in 1889, and has since been used for various purposes, including steam tricycles and carriages, by M. Serpollet and others.*

In the boiler of the carriage shown in Fig. 34, a pressure of about 300 lb. is carried. The engine consists of a pair of horizontal cylinders, 2½ inches in diameter, and 2¼ inches stroke, the crankshaft being connected

FIG. 34.

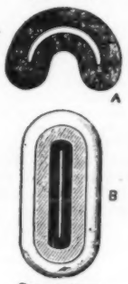


SERPOLLET STEAM CARRIAGE.

to the driving wheels by means of pitch chains. The exhaust steam passes into the chamber above the fire space, and so passes away into the chimney in a superheated condition, so that it is generally invisible, the discharge taking place beneath the carriage. The coke storage is sufficient for a journey, under good conditions, of 40 miles, but the water tank has to be refilled several times in that distance. The pump used for supplying the boiler is of about 1 in. in diameter, and of very short stroke, about three-quarters of an inch.

Fig. 34 shows the construction of the engine as used by M. Serpollet. The pistons of the two cylinders are connected to two cranks on a crankshaft, which, by one pinion, conveys motion to a second motion shaft,

FIG. 35.

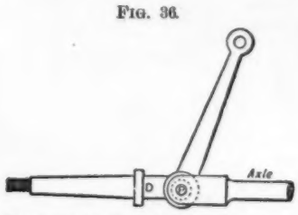


SERPOLLET BOILER TUBE, ETC.

on which is a compensating motion gear. On the ends of this are ten tooth chain pinions for the pitch chain by which the road wheels are driven †. It must be understood that it is an instantaneous generation boiler, the tubes being capable of withstanding the heat of the furnace whether there is water in them or not, so that the question of regulation is got over by the water only being admitted to these tubes when the engine wants steam, or, in other words, when the engines are at work. That gets over one of the greatest difficulties with reference to the use of steam for road carriages. The boilers for fixed engine are made on the same principle, but to prolong the life of the tube and to improve the action of the boiler on the instantaneous system, is cast into a surrounding of cast iron, so that the tube itself, which has to stand the pressure, and which receives the heat, is protected by a very large heat regulating medium.

The tube used in motor carriage boilers is of the section shown at A, Fig. 35, and that used as cast into

FIG. 36.



STEERING AXLE, SERPOLLET CARRIAGE.

a cast iron surrounding is shown at B. Mr. Bryan Donkin had one of the Serpollet carriages in London, and made numerous experiments with it about four years ago. The steering is effected by a hand lever and connecting rods, which control the short joints shown in Fig. 36 and Fig. 42, each short axle at the end of the main fixed, fore axle moving independently, as on Akerman's system of carriage axles, invented and used in 1819.

A small oil motor carriage has been made by Mr. J. H. Knight, of Farnham. It is a three-wheeled vehicle, one of the hind wheels, which are 3 feet in diameter, being a driver. The engine consists of a single cylinder of 3½ inch diameter and 4½ inch stroke, capable of giving ¾ B. H. P. at 500 revolutions per minute. The arrangement of the gear included two speeds brought into use by means of ropes running on grooved pulleys, with a pair of jockey pulleys to put the one or the other into action, giving a speed of from about 3½ to about 7½ miles per hour.‡ The engine drives from the crank shaft to an intermediate shaft

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* From the Journal of the Society of Arts.

† The Engineer, July 20 and 27, 1894, pp. 47 and 86.

‡ The Engineer, July 12, 1895, p. 36.

§ Much of the objection to traction engines would be removed if all the makers and users would case in the fly wheel and working parts.

* The Engineer, vol. lxxii, p. 26, September 27, 1895, p. 214, and October 25, 1895.

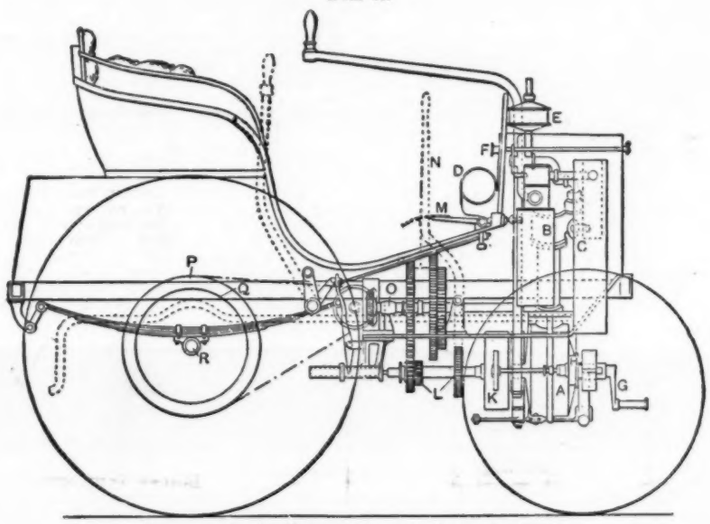
† Engineering, October 18, 1895, p. 499.

‡ The Engineer, September 13, 1895, p. 232.

by the ropes mentioned, and the latter drives the road wheel by means of a pitched chain. The engine was at first made to run with benzoline, but Mr. Knight now informs me that he is successfully running it with ordinary lamp petroleum. The weight of the carriage as shown, capable of carrying two persons, is 575 pounds. It was built as an experiment; and as Mr. Knight has already succeeded in using oil of a high flash point, he has experimented to some advantage.

The carriage next to be described is that which received the second prize in the Paris and Bordeaux race organized by the Petit Journal last July. It performed the journey in the shortest time, but as it only carried two persons, it was not awarded the first prize. The carriages are made in several forms, one of the best being the form purchased and used by the Hon. Evelyn Ellis. The arrangement of the gear is seen in Fig. 37. The engine employed, like that of so many of the French carriages, is the Daimler motor, a well-known vertical engine, running at a high speed and using benzoline. It has two cylinders, set at an angle of about 15°, and coupled to a crank partly formed by a pair of fly wheel disks. This motor is entirely inclosed in a box, which also contains the vaporizer, B, and an exhaust box, C. The reservoir for carrying the benzoline is seen at D. At E is the regulator for controlling the supply of benzoline to burners for heating the ignition tubes. At H is a small centrifugal pump driven by a belt on the pulley, J, for circulating the water round the cylinder jackets. Gearing is arranged for three different speeds, the cog wheels, L, being

FIG. 37.



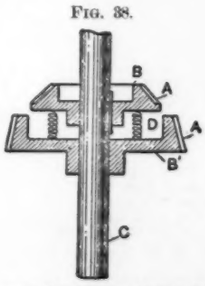
PANHARD AND LE VASSOR'S DAIMLER MOTOR CARRIAGE

made of gun metal, and movable so that they may either of them be made to engage with the three wheels above them; they are made tight or loose upon the crankshaft by means of friction clutches at K. The intermediate shaft driven by this gear conveys motion by another intermediate shaft, placed transversely across the carriage, and carrying a pair of pitch chain pinions which drive the road wheels by a pitch chain on sprocket wheels attached to their spokes. A differential or compensating motion is fitted to the transverse intermediate shaft. To alter the speed while the engine is running, the pedal, M, is depressed, and the gearing then brought to rest by means of the lever, N. The change in the position of the gear wheels is then made, the cogs all being rounded at their corners to enable them to find their way into the corresponding teeth of the upper wheels.

A pulley, Q, is placed upon the driving wheels, and used for carrying a brake instead of putting a brake on the tires of the road wheels.

The clutch already referred to is shown by Fig. 38. The shaft, C, is the crankshaft, upon which is fixed the coned disk, B. In front of this and sliding upon a feather is another friction cone, the face of which has a greater angle. When the containing or interior cone disk which encircles these is pushed against these inner cones, the smaller one retires into the larger one against the resistance of the springs, D, and when the frictional contact due to this resistance is reached, the further frictional contact and more powerful grip of the disk, B', is obtained, the object being as far as frictional cone clutches makes it possible to put the carriage gradually into motion; the faces of the cones, B and B,' are coated with leather at A and A'.

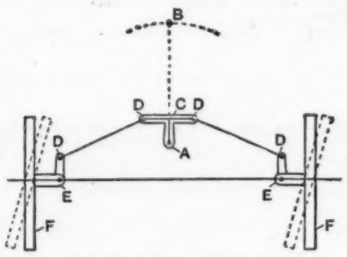
FIG. 38.



PANHARD AND LEVASSOR FRICTION CLUTCH.

The steering is effected by means of front wheels running on short axles, as seen in the diagram, Fig. 39. The system, it may be mentioned, is that of Ackerman, already referred to. F F are the steering wheels, with axles pivoted at E, and operated by rods from the steering lever at D. This form of steering gear removes some of the difficulties connected with a straight axle

FIG. 39.



PANHARD AND LE VASSOR STEERING GEAR.

and fore carriage of the ordinary kind, and it, moreover, secures good control and steady movement.

The Daimler motor,* to which reference has already been made, as seen in Fig. 37, is used by several of the continental firms of builders of motor carriages. Quite recently it has been much modified, and takes the form which will be referred to hereafter in connection with the Daimler carriage.

(To be continued.)

HOW TO BUILD A MINIATURE YACHT.

By W. J. HENDERSON.

THE sailing of miniature yachts affords a great deal of pleasure to those who have not the time or the means to indulge in sailing full grown vessels. But the pleasure of sailing these little craft is increased tenfold when the yacht is the work of one's own hands. To build what may fairly be called a model yacht, one that reproduces in herself the lines of some famous flier of heavy tonnage, requires the skill of an expert designer; but any man with an ordinary amateur sailor's knowledge of hulls, rig, and sails can make a boat that will sail well. The first thing to do is to draw a design on a stout sheet of paper. This design should show the three plans always used by yacht builders—body, half breadth, and sheer plan. It is not necessary that the amateur should be able to originate these plans. On the contrary, it would be better for him to copy them from some one of the many books containing designs. Even if he uses the design of a ninety footer, he can reduce the scale to a quarter inch for every foot, and so get a perfectly proportioned two footer.

When it comes to building, he may follow one of three ways: the block, the "bread and butter," or the built up method. The first is very convenient for a small model, and the last is the only satisfactory way for boats four or five feet long. The three methods briefly described consist, first, of carving the hull out of a solid block; second, of building it out of several horizontal sections cut to the proper shape and glued one upon the other; third, of constructing the hull in miniature out of almost as many separate pieces as there are in a large yacht. For the great majority of those who will wish to build miniature yachts the simplest plan is the block method.

The first requirement is a piece of clear, soft white pine of sufficient size. Draw upon the upper surface of this block with a black pencil the deck line as shown in your design. Now draw a straight line through the center of the deck from stem to stern, carrying it down the ends and along the bottom of the block. The sides should now be cut away perpendicularly to the deck line. If you are near a cabinet maker, he can do this neatly with a saw. You must next draw carefully on the sides of your block the sheer plan of your model, including, of course, the sheer of the deck. You may now proceed to cut away the top of the block until the deck has come to the proper shape. Now mark again the center line from stem to stern. You are now ready to go to work at shaping the hull. Before doing this you should have several patterns cut out according to the lines of your body plan, showing the shape and width of the hull at various points from stem to stern. By applying these patterns—which will look something like the chocks in which a model sits when on exhibition—at the proper places as you gradually cut away the wood, you will get your hull to assume the shape indicated by the design. Try these patterns very frequently and work very slowly, or you may find that you have cut away too much in some one place, and then your model is spoiled.

Having finished the cutting, work over the hull with sand paper, using No. 2 first and No. 1½ afterward. Now begins the delicate task of cutting out the interior of the hull. For an ordinary toy boat the hull may be left solid; but for a firstclass model yacht this will not do, because the density of the wood will sink her below her designed water line. It is necessary to build a cradle to hold the hull firmly while you are cutting out. The cradle may consist of bow and stern chocks connected by strips of wood. Now draw a line around the deck two-thirds to three-fourths of an inch from the outside, and cut out the wood inside of this line, going down straight at first and afterward following the shape of the hull. The sides should be from one-fourth inch thick for a little boat to one-half inch for a three footer.

Next you must cut out your deck beams one-fourth inch thick and one-half inch deep. If you wish your deck to curve, of course the top of the beams must curve. Cut them to the proper length and mortise them into the sides of the boat, the upper edges even with the tops of the sides. If you wish a hatchway, you must put two fore-and-aft pieces between the beams where the opening is to be. Now cut the deck out of light mahogany or pine one-eighth inch thick, and one-eighth wider than the boat. Nail it on, and round off the outer edge with sand paper to form the plank sheer. Next make the boat's rail, not over one-fourth inch thick, and nail it on. It is a good plan, as a matter of precaution, in nailing on a rail to bore small holes for the nails, so that they will not split the sides when driven in. Very small wire nails are the best for this work. This whole labor of cutting out and shaping a hull requires a delicate hand and a good deal of patience, and it is a very unsatisfactory employment for a hasty person.

A hollow box of the required form for the lead keel is now made and rubbed with chalk. The lead is melted until it will just run and is poured into the box. As soon as it is cool, it can be taken out and trimmed with any steel cutting instrument. The keel is bolted to the hull by long brass screws. You can have a regular fin keel if you like, by cutting out a sheet of brass and bolting it to two flat pieces screwed to your vessel's bottom. Then mould your lead bulb in halves and bolt them to the foot of the fin. You now come to the rig. The dimensions of the spar plan of a fine model, given by W. P. Stephens, are as follows: Length of water line fifty-two inches; mast abaft forward end of water line, nineteen inches; mast, deck to hounds, forty-six inches; masthead, seven and one-half inches; topmast, forty-two inches; bowsprit, outboard, nineteen inches; boom, fifty-four inches; gaff, thirty-four inches; tack to peak, sixty-eight and three-fourth inches; clew to throat, sixty-five inches; topsail yards, seventeen by thirty-seven inches. By following these proportions you will have a good model.

Make the mast, boom, and gaff out of clear spruce. Ash or hickory is good for the bowsprit. The mast should be one-half inch in diameter for a three footer. It should be set in a brass tube inside the hull. Put a tight plug of wood in the bottom of the tube and run a screw into it through the bottom. All the fittings of the rigging of a model yacht are made out of brass, which can be cut and bent to the required shape with a few simple tools and a little ingenuity. There are some large sporting goods stores where all these fittings may be bought ready made at reasonable prices, and for one who has a little money to spend on his model this is most convenient. The rigging of a model yacht is so much a matter of taste that it must be left to the builder's own fancy. It may be suggested, however, that the best material for the shrouds is waterproof fishing line.

There are two plans for arranging the rudder. One is by means of weights of lead, which may be attached to the after edge of the rudder itself or to a tiller extending abaft the rudder post instead of forward. When the boat heels, the rudder swings to leeward, and so keeps her off till her mainsail fills and sends her head toward the wind again. The other plan is more complicated, and somewhat difficult to describe without the use of pictures. Through the head of the rudder post a short tiller runs aft instead of forward. A rubber band extends from the end of the tiller to a point further astern and exactly amidships. This band tends to pull the tiller back amidships whenever it is to port or starboard. A small curved wire, with a screw thread, should be set upon the deck so that the after end of the tiller will move just above it. On this wire a thumb nut should be placed on each side at the point where the tiller should stop when the boat is properly balanced. Of course, when the tiller strikes the thumb nut it can go no further. Near the end of the tiller is a ring, through which the mainsheet is rove from the boom. The end of the sheet is carried forward and made fast, the sheet being very slack. The pull of the mainsheet through the ring puts the helm over, and the rubber band hauls it back.

This automatic gear will steer a miniature yacht excellently when she is sailing with the wind aft or abeam. In sailing to windward, miniature yachts are steered entirely by the sails, and the rudder is kept amidships. For this purpose Mr. W. P. Stephens recommends a second sheet, rove through a traveler. The after end of this sheet is fitted with a spring snap, while the forward end is made fast, the sheet being hauled taut. There must be a ring on the boom to catch the spring snap, which is attached to it when you wish to send the boat to windward. The rubber band now holds the tiller amidships.—The Outlook.

* The Engineer, vol. lxxv, p. 322.

THE application of a cold water compress, covered with a bandage of flannel, has proved efficacious in the night sweats of phthisis after the usual remedies had failed.

THE STORY OF HELIUM.*

By J. NORMAN LOCKYER, in *Nature*.

CHAPTER II.

MY next chapter breaks new ground. I take you right away from the celestial regions, we leave the sun for a time, and I land you at Washington. I take you to a room in the geological department there, and I introduce you to one of the officials at work—a certain Dr. Hillebrand.

He is engaged upon the chemical examination of specimens of the mineral uraninite from various localities. The time was the year 1888.

He deals with a little crystal such as I have in my hand, he puts it in a vessel containing some sulphuric acid and water. He finds that he gets bubbles, bubbles of gas produced out of the crystal by means of the sulphuric acid. Well, he collects this gas, gets a quantity of it, tries to find out what it is, and he comes to the conclusion that it is nitrogen, and he publishes a statement that this gas obtained from the mineral uraninite consists of nitrogen.

This result was new. He thus writes about it:

"In consequence of a certain observation" [the one I have just referred to] "and its results, an entirely new direction was given to the work, and its scope wonderfully broadened. This was the discovery of a hitherto unsuspected element in uraninite, existing in a form of combination not before observed in the mineral world."

It is not needful for my story to follow Dr. Hillebrand through all the painstaking and patient labor he cut out for himself, to explain this anomalous behavior. Needless to say he did not omit to employ the spectroscope to test the nature of the new gas.

He writes:†

"In a Geissler tube under a pressure of ten millimeters and less, the gas afforded the fluted spectrum of pure nitrogen as brilliantly and as completely as was done by a purchased nitrogen tube. In order that no possibility of error might exist, the tube was then reopened and repeatedly filled with hydrogen, and evacuated till only the hydrogen lines were visible. When now filled with the gas and again evacuated, the nitrogen spectrum appeared as brilliantly as before, with the three bright hydrogen lines added."

On this paragraph I may remark that it has long been known that gases like nitrogen give us quite distinct spectra at different temperatures—one fluted, another containing lines. Which of these we shall see in a tube will depend upon the pressure of the gas and the electric current used. The fluted spectrum of nitrogen is very bright and full of beautiful detail in the yellow part of the spectrum; the line spectrum, on the other hand, is almost bare in that region.

Note well that it so happened that the pressure and electric conditions employed by Dr. Hillebrand enabled him to see the fluted spectrum.

Dr. Hillebrand concludes his paper by pointing out that

"The interest in the matter is not confined merely to a solution of the composition of this one mineral; it is broader than that, and the question arises, May not nitrogen be a constituent of other species in a form hitherto unsuspected and unrecognizable by our ordinary chemical manipulations? And, if so, other problems are suggested which it is not now in order to discuss."

CHAPTER III.

Now, I have another part of the story to bring before you.

Following the recognized practice of story tellers, I have to change the scene; instead of dealing with the sun, I must take you still further afield and consider some points connected with distant suns, which we call stars, and the nebulæ which are so often associated with those distant suns. A star appears to us as a point, but a nebula appears to us a surface, and the result is that the method of investigating these two classes of heavenly bodies, to get at the facts I have to bring before you, is somewhat different.

Let us deal, in the first instance, with the method of photographing the spectrum of a star which appears to us as a point. The best way of doing that is to use an instrument represented in this diagram, which consists of a telescope with an object glass at one end in front of which a prism of large dimensions is fixed, through which the light has to pass before it enters the telescope at all.

Hence on the photographic plate, instead of the point formed by a star under ordinary conditions, owing to the tearing asunder by the prism of the different colored rays of which the white light of the star is composed, we get a fine line, along which is represented the complete radiation, or complete system of hieroglyphics, from red to violet.

Another method is to employ a spectroscope of the ordinary construction in connection with a large reflector. The light from the star, which is grasped by the large mirror, is thrown by a diagonal mirror inside the tube on to the slit. In the case of the nebulæ, of course allowing first one part and then another to fall upon the slit of the spectroscope, we are enabled to determine what light notes build up its light, and whether the light notes from every part of the nebula are absolutely the same, or whether there are differences of chemical constitution in different parts. In this way it was found many years ago that both in the light of stars and of nebulæ we get very considerable varieties of spectra. Let me prove this point by referring to some recent observations.

The original negative of the nebula of Orion, taken at my observatory at Westgate-on-Sea, in 1890, contains fifty-six lines, and of course by determining, as we have been able to do, the wave lengths—the positions of these lines in the spectrum—we can determine the exact light notes represented, and therefore the substances which produce them. Now I have to tell you that in this spectrum of the nebula of Orion we get lines of unknown origin exactly coinciding with those unknown lines which I have already referred to as having been seen in the sun's atmosphere. Mark it well, that some of the unknown lines in that atmosphere, those that we have not been able to see in our laboratories, are identical in position with some of the unknown lines in the nebula of Orion, the line D^3 being one case in point.

Then, I have next to say that in the spectra of many stars we have these same lines, which we have so far classified as unknown for the reason above stated, that in our laboratories we have not been able to get any lines which correspond with them.

I call attention to the spectra of some stars which have been carefully photographed and measured. You will see that the progress of this branch of science lately has been so considerable that any statement made with regard to the positions of lines, and therefore the chemical origins of them, may be made with a considerable amount of certainty as depending upon accurate work.

It forms no part of my present purpose to indicate the various classes in which the stars have been classified by different observers according to their spectra, but some of the more salient differences must be pointed out. Thus we have stars with many lines in their spectra, others with comparatively few. I will take the many-lined stars first.

The diagram (Fig. 9) represents the spectrum of Arcturus, a star the spectrum of which closely resembles that of the sun. In α Cygni we have another star with many lines, but here we note, when we leave the hydrogen on one side and deal with the other stronger lines, that there is little relation between the solar spectrum and these lines.

I next come to the stars with few lines. These are well represented by many of the chief stars in the constellation of Orion. Bellatrix is given as an example (Fig. 10).

Some astronomers hold the view that all the stars were hotter when they were first formed than they ever have been afterward. I have attempted to prove not only that this view is unphilosophic, but, further, that the spectroscopic facts indicate that we can arrange the stars along one line, provided the hottest stars are supposed to occupy the middle of it. In other words, that stars begin to cool, get hotter, and then cool down finally.

In this way we are enabled to trace the chemical changes from one star to another, and that has been done with an expenditure of considerable labor.

FIG. 9.—Spectrum of Arcturus between G and K.

CHAPTER IV.

Now I go to another chapter of my story. I ask you to accompany me in your mind's eye to another eclipse. The importance of eclipses in the abstract I think you will grant, from some of the results which I have referred to. A method which was first employed by Respighi and myself during the eclipse of 1871 was employed on a large scale and with great effect during the eclipse of 1893. The light proceeding from the luminous ring round the dark moon was made to give us a series of rings, representing each bright line seen by the ordinary method, on a photographic plate. The observers this time were stationed in West Africa and in Brazil. The African station was up one of the rivers, not very far away from the town of Bathurst.

As a matter of fact, the very same instrument which was previously referred to as used for obtaining photographs of the stars was sent here, in order that photographs of the eclipse of the sun might be taken on exactly the same scale as the photographs of the stars had been. We next come to the Brazilian station. Here again the instruments were somewhat similar. I have another view of the Brazilian station, and it affords me very great pleasure to bring this before you, because it enables me in this public way, as president of the Vesey Club, to tender thanks to Sir Benjamin Stone for the help he gave the Brazilian party.

FIG. 10.—The spectrum of Bellatrix between H and F.

We next pass to the results which were obtained by Messrs. Fowler and Shackleton, who were in charge of the instruments at the two stations. The diagrams will indicate the kind of celestial hieroglyph—to come back to the old image—we have to deal with when this method is employed.

We get more or less complete rings when we are dealing with an extended arc of the chromosphere, or lines of dots when any small part of it is being subjected to a disturbance which increases the temperature and, possibly, the numbers of the different vapors present.

The efficiency of this method of work with the dispersion employed turns out to be very marvelous, and in securing such valuable and permanent records as these, you will acknowledge that we have done very much better than if we had contented ourselves with the style of observations that I have referred to as having been made in 1871.

And now the plot of my story begins to thicken. On examining these eclipse records, we find that we have to do exactly with those unknown lines which had already been photographed in the stars and in the nebulæ.

As was to be expected, we, of course, deal with the lines recorded in the first observations of the solar disturbances, and chronicled in that table of Prof. Young's to which I have already called attention; but the important thing, the unexpected thing, is the marvelously close connection between eclipse and star spectrum photographs.

FIG. 11.—Untouched reproduction of photograph (African station) taken very shortly after the commencement of totality, the exposure being "instantaneous." At this phase of the eclipse a considerable arc of the chromosphere was visible, and its spectrum is therefore shown in addition to the spectrum of the higher reaches of some of the large prominences extending beyond the moon's limb. It will be seen that at K and K there are long arcs of chromosphere and prominences, the absent portions being of course obscured by the moon. One very small prominence is especially rich in lines.

* Continued from SUPPLEMENT, No. 1056, page 16885.

† "On the Occurrence of Nitrogen in Uraninite," Bulletin, No. 78, U. S. Geol. Survey, 1889-90, p. 55.

CHAPTER V.

Again I recall you from the heavens to the earth; the time is the beginning of the present year.

You remember that last year was made memorable by the announcement of the discovery by Lord Rayleigh and Prof. Ramsay of a new gas called argon, and you know that the discovery was brought about chiefly in the first instance by the very accurate observations of Lord Rayleigh, who found that when he was determining the weight of air in a globe of a certain capacity, the weight depended upon the source from which he got the nitrogen.

From the nitrogen from atmospheric air he obtained one weight and from that obtained by certain chemical processes he obtained another, and ultimately it was found that there was an unknown element which produced these results, these various changes in the weight; and as a consequence we had the discovery of argon.

It struck Mr. Miers, of the British Museum, that it might be desirable to draw attention to the nitrogen which we have seen Dr. Hillebrand in 1888 obtaining from his crystal of uraninite; his observations, of course, were more in the mind of Mr. Miers than in the minds of the pure chemists. He therefore communicated with Prof. Ramsay, who lost no time, because it was very interesting to study every possible source of nitrogen and see what its behavior was in regard to the quantity of argon that it produced, and in the relation generally of the gas to the argon which was produced from it.

Prof. Ramsay treated uraninite in exactly the same way that Dr. Hillebrand had done in 1888. The gas obtained as Dr. Hillebrand had obtained it was eventually submitted to a spectroscopic test, following Dr. Hillebrand's example. But here a noteworthy thing comes in.

It so happened that the pressure and electrical conditions employed by Prof. Ramsay were so different from those used by Dr. Hillebrand that, although nitrogen was undoubtedly present, the fluted spectrum which, as I have previously stated, floods the yellow part of the spectrum with luminous details, was absent. But still there was something there.

Judge of Prof. Ramsay's surprise when he found that he got a bright yellow line; that was the chief thing, and not the strong suggestion of the spectrum of nitrogen. Careful measurements indicated that the twenty-six year old helium had at last been run to earth, D^3 was at last visible in a laboratory. Prof. Ramsay was good enough to send specimens of the tubes containing this gas round to other people, and he sent one of them to me.

I received Prof. Ramsay's tube on March 28, but as it was not suitable for the experiments I wished to make, in his absence, I obtained some gas for myself by a different method with which I need not trouble you. From March 30 onward my assistants and myself had a very exciting time. One by one the unknown lines I had observed in the sun in 1868 were found to belong to the gas I was distilling from brögerite, not only D^3, but 4,923, 5,017, 4,471 (Lorenzoni's f), 6,677 (the BC of Fig. 7), referred to previously, and many other solar lines, were all caught in a few weeks.

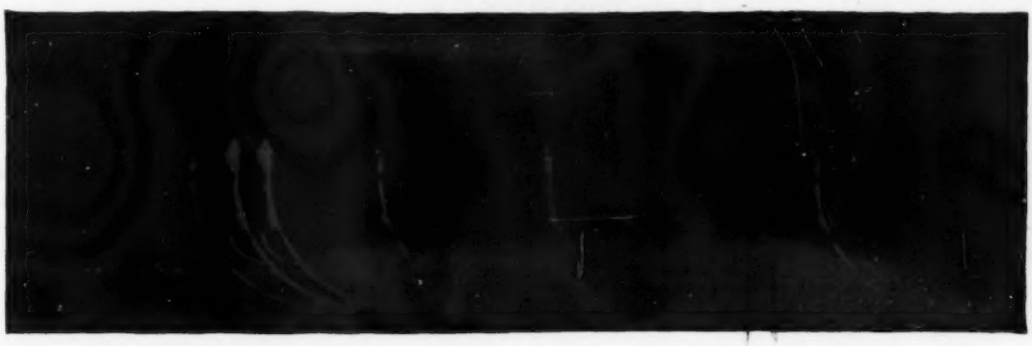


FIG. 12.—Photograph 21 (African station) taken shortly before the end of totality. A portion of the chromosphere on the other edge of the dark moon is now visible in addition to numerous prominences. It will be seen that one of the smallest prominences is rich in lines, and closely resembles that which appears in Fig. 11.

But this was by no means all. The solar observations had been made by eye, and referred therefore to the less refrangible part of the spectrum, but I had obtained and studied hundreds of stellar photographs. So I at once proceeded to photograph the gas and compare its more refrangible lines with stellar lines.

Here, if possible, the result was still more marvelous. In the few lined stars, by May 6, I had caught nearly all the most important lines at the first casts of the spectroscopic net. Fig. 13, which includes some later results, will give an idea of the tremendous revelation which had been made as to the chemistry of some of the stages of star life.

These results enabled us at once to understand how it was that the "unknown lines" had been seen both in the sun's chromosphere and some nebulæ and stars. The gas obtained from the minerals made its appearance in the various heavenly bodies in which the conditions of the highest temperatures were present, and the more the work goes on we find that this gas is really the origin of most, but certainly not of all, of the unknown lines which have been teasing astronomical workers for the last quarter of a century.

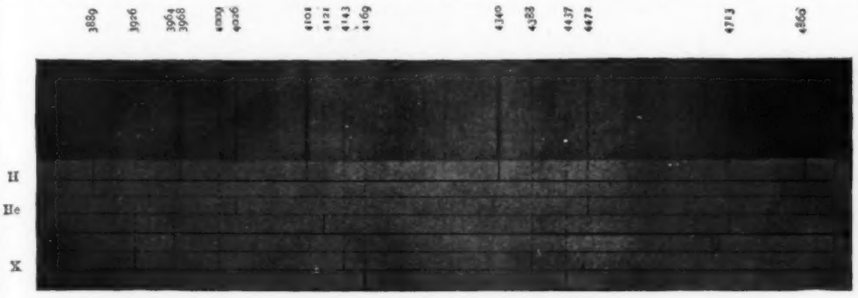


FIG. 13.—The spectrum of Bellatrix showing the lines of hydrogen and those which have been traced to the gas obtained from minerals.

A great deal of work has been done upon these gases from other points of view than those which affect my story, and perhaps I may be allowed just to refer for a minute or two to one of the results which have been obtained by myself.

It is perfectly obvious that the gas as obtained from uraninite is a mixture of several gases; that the gas which gives the yellow line has not yet been isolated, but is always mixed up with other gases which give other lines.

In May I communicated to the Royal Society some experiments which indicated in a most conclusive manner the fact that the lines D^3 and 667, to deal with two only for the sake of simplicity, were not produced by the same gas, and that 667 seemed to be a compound gas of which D^3 represents one of the constituents.

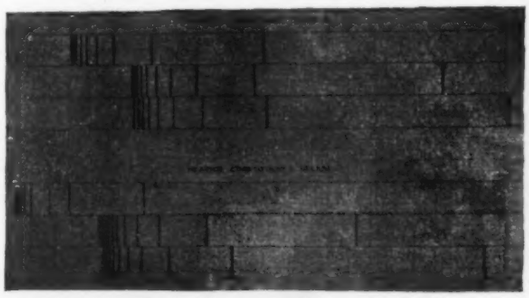


FIG. 14.—Runge and Paschen's results suggesting that clevelte gives off two gases, each with three series of lines.

Some little time after, Profs. Runge and Paschen, from an entirely different standpoint, arrived at exactly the same conclusion. They recognized two gases, one represented by D^3, the other by 667, and further they showed that the lines might be arranged into six similar and beautifully rhythmic series, a principal and first and second series for each gas. These are indicated in the diagram of Bellatrix annexed, and in Fig. 14. He = helium is the gas which contains D^3; the other gas I so far call "gas X."*

This result is, however, more important from the chemical than from the astronomical point of view at present.

A word in conclusion referring to the occurrence of this gas in terrestrial minerals.

We are brought face to face with one question, which ought to influence many lines of work for many years to come. I have already suggested to you that we really now can talk with something like certainty and definiteness about hot stars and cooler stars, and that in the hottest stars we know of the atmospheres of those stars consist almost entirely of hydrogen and helium.

But see what a little trace of helium we have in this small planet of ours, which was undoubtedly once a sun, which undoubtedly once had an atmosphere just as glorious in its hydrogen and its helium as any of the other stars are now glorious.

What has become of that helium? This question will have to be very carefully considered in the next few years.

We appear to be in the presence of the vera causa, not of two or three, but of many of the lines which so far have been classed as "unknown" by students both of solar and stellar chemistry, and we are also apparently in the presence of a new order of gases of the highest importance to celestial chemistry, though perhaps they may be of small practical value to chemists, because their compounds and associated elements are for the most part hidden deep in the earth's interior. Why do I suggest a new order of gases? Look at the facts.

All the old terrestrial gases, with the exception of hydrogen, are spectroscopically invisible in the sun and stars—though they doubtless exist there—and these new gases, scarcely yet glimpsed, have already supplied us with many points of contact between our own planet and the hottest part of our central luminary that we can get at and stars like Bellatrix.

The work certainly is full of hope for the future, not only in relation to the possibility of more closely correlating celestial and terrestrial phenomena, but since it indicates that terrestrial chemistry, founded on low density surface products in which nonsolar gases largely enter, is capable of almost infinite expansion when the actions and reactions of the new order of gases, almost, it may be said, of paramount importance in certain stages of stellar evolution, shall have been completely studied.

I have some other results to refer to, but it is quite sufficient, I think, to leave my story as I have told it to you without going back on any of the characters, or without dealing in any greater detail with the denouement of the plot.

But the story has a moral. The more we can study the different branches of science in their relation to each other, the better for the progress of all the sciences. Another point is that in the study of nature we behave in a very foolish way if we think there is anything unimportant which comes under our eyes. If it had so happened that Dr. Hillebrand had seen the line spectrum of nitrogen in 1888, we should have saved all these seven years of waiting for this terrestrial source of helium; and I may add, further, that argon would have been discovered as well in the first hour's work. In science, results of the first importance depend upon the minute examination of so-called residual phenomena; it is too much the general tendency, of scientific work on a large scale, to think too much of those results which may have a practical importance.

Geologists, natural philosophers generally, have been familiar with the mineral world for a considerable number of years. What have they been doing all the time? They have confined their attention too exclusively to the contained metals, and have neglected the gases; whereas it now seems that if they had been less careful of the metals, and had studied the gases, it would have been very much better for our nineteenth century knowledge. And that is the moral of my simple story.

THERE are in Arizona 10,000,000 acres of desert land capable of reclamation to agriculture through irrigation. Already some 997,000 acres have been reclaimed and are bearing profitable crops of various kinds, and various enterprises are now under way which, it is expected, will in the next two years insure the reclamation of almost 2,000,000 acres more.

* In the many comparisons I had to make, I soon found the inconvenience of not having a name for the gas which gave 667, 501, and other lines. When, therefore, Profs. Runge and Paschen who had indorsed my results, and had extended them, called upon me, I thought it right to suggest to them that, sinking the priority of my own results, we should all three combine in suggesting a name. Prof. Runge (under date October 20) wrote me: "The inference that there are two gases is a spectroscopical one, being based on the investigation of the 'series.' Now, though we think this basis quite sound, we must own that the conclusion rests on induction. . . . For this reason we do not want to give a name to 'gas X.'" I have so far suggested no name, though Orionium and Asterium have been in my mind,

ON VIVISECTION.

By Prof. THEOPHILUS PARVIN, M.D., LL.D., of Jefferson Medical College, Philadelphia, Pa.

THE subject of bacteriology has, I believe, undue importance in professional study and teaching. . . . May not a similar statement be made in regard to vivisection? My belief is that the value of this method of study in relation to surgery and therapeutics has been exaggerated. So far as the first department is concerned, reference will be made to abdominal and to brain surgery. If Mr. Tait's statement is accepted—and his authority and ability none can justly question—vivisection has been an injury, not a help, to the former. His declarations upon this point have been positive and frequent. One of the most recent, 1889, is as follows: "Instead of vivisection having in any way advanced abdominal surgery, it has, on the contrary, retarded it."

Those engaged in brain surgery sometimes refer to the great advantages obtained by vivisection in cerebral localization; but Dr. Seguin, whose authority will be admitted, referring to a paper by Horsley, makes the following statements: "The author appears to assume that our progress in cerebral localization has been mainly dependent upon experimentation. Here again we must differ from him. Clinical observation and pathological data come first (Broca for speech center, Hughlings-Jackson for a hand center and general doctrine), the animal experiments with detailed proofs by Hitzig, Ferrier, and others long after; and the solid facts upon which we make our daily localization diagnoses have been patiently accumulated by pathologists, and would stand to-day supporting the doctrine of cerebral localization if not one animal's brain had been touched. Besides, in the case of the visual half center, human pathological facts have overthrown the result of experimentation (Ferrier's angular gyrus center), and have made us, for practical purposes, indifferent to the contradictory results of Munk and Goltz. It is safe to say that every one of the so-called 'centers' in the human brain have been determined empirically by post-mortem proofs, independently of experimental data. What animal experiments would have led us, for example, to locate the half center for ordinary vision in the cuneus, the center for the leg in the paracentral lobule, and that for audited language in the left first temporal gyrus? In this department of pathology medical science has been strictly inductive and sufficient unto itself, though receiving confirmatory evidence from the physiologist. The first (speech) and the last (visual) centers have been discovered by clinical and pathological studies."

Facility in operating is one of the advantages claimed for vivisection, and the claim is just. Nevertheless, the animals thus used for the education of the surgeon ought to be completely anæsthetized during operations, and killed immediately after, and not left to live days of suffering. Moreover, it should be remembered that great surgeons have made their work intelligent and facile by operations upon the human cadaver; the glory of many of our country's dead surgeons has never been eclipsed by any of those now living, no matter how much time they have given to vivisection.

What shall be said of the value of experimental therapeutics? The shortest and most positive answer is that given by one of the highest French authorities, Dujardin-Beaumetz: "Experimental therapeutics exist only in name, and will continue nominal until we are able to create at will in animals the diseases common to mankind."

The famous Hyderabad Commission, after killing hundreds of animals, chiefly dogs, by chloroform anæsthesia, concluded that death occurred from asphyxia, and never from syncope; and therefore in the administration of chloroform as an anæsthetic to human beings, the respiration only need be observed. Dr. Richardson shows that the inference is erroneous, stating that "its first failure arises from the fact that the reasoning soul, as Thomas Willis calls it, is left out of the argument." Not only this, but equally able and eminent experimenters with those concerned in the Hyderabad investigations have shown that dogs may, when killed by chloroform inhalation, perish from syncope, or from syncope and asphyxia, instead of from the latter only. Differences of climate and difference of dogs have been suggested as explaining these different results. Who shall compose these strifes? What uncertainties may belong to investigations made by the most skillful, and how unwilling should medicine be to accept all conclusions of the laboratory as certain truth!

Medicine does not accept in all cases such conclusions. For example, doctors, relying upon clinical experience, give certain mercurials to excite the hepatic secretion; but this practice ought to have been abandoned long ago when the experiments of Rutherford proved that in dogs no such result followed. Imagine the experimental therapeutist giving a patient a dose of calomel, who innocently asks, "Is thy servant a dog that this drug is given me?" The doctor of course can reply, though the imperfection of his method is thus confessed, "No; it is because you are not a dog that I prescribe it."

Some two years since, Herbert Spencer having suggested to Huxley that in case he were sick he would employ a practitioner who trusted in the teaching of experimental therapeutics, the latter replied, "Heaven forbid that I should fall into that practitioner's hands! and if I thought any writings of mine could afford the slightest pretext for the amount of manslaughter of which that man would be guilty, I should be sorry indeed."

When one reads the experiments made upon animals with some well known remedies, very probably he finds no addition of a practical sort to his knowledge; he learns nothing as to when, in what doses and intervals, the medicines are to be administered. Digging post holes and fixing posts in them will define boundaries, but do not make a fruitful orchard.

When we consider that drugs do not act upon man invariably as they do upon inferior animals, nor when thus acting they may not in corresponding doses; and that animals differ among themselves as to susceptibility; and that, finally, these animals are not suffering from the diseases for which in the human subject the remedies are to be given, not indeed afflicted with any disease; it must be obvious that there are sources of fallacy inherent in the method and that false conclusions may result.

Whether the good outweighs the evil, whether the profit in this business is greater than the loss, must be finally decided not by ardent vivisectionists who are liable to become intolerant and aggressive, nor by zealous anti-vivisectionists, who may exalt sentiment above knowledge and reason, but by the calm, continued observation and experience of conscientious, intelligent practitioners.

It seems to me that the most valuable result of experiments upon animals has been in the discovery of the etiology of so-called septic infection; and hence the means, whether aseptic or antiseptic, by which this great evil may be usually averted.

Pasteur's investigations as to the cause of hydrophobia and the employment of preventive inoculations, require longer observation and experience for appreciation. Koch's method of cure of tuberculosis rates much lower than it did a few months ago. It is not beyond the bounds of possibility that before many years the average results from anti-hydrophobic and anti-tuberculous inoculations will be of such an unfavorable character that they will give one of the strongest arguments against vivisection.*

There are certain presumptive arguments against vivisection. If there be a God of love and power, without whose knowledge not even a sparrow falls to the ground—a God who giveth to the beast his food and to the young ravens which cry—who is good to all, and whose tender mercies are over all His works, surely it is not in accordance with His character and purposes that animals should undergo cruel tortures for man's benefit.

The animal creation has been made subject to man; many of them are our dependents, and some capable of the strongest attachment to human beings, and become the most devoted friends. Even the wild animal sometimes appeals in its distress for human help.

What might not all animal creation become to man if everywhere the law of kindness ruled his action! Physicians, whose very name points to widest sympathy with nature, ought to be the chief apostles in preventing cruelty and proclaiming kindness to animals as the duty of man, and therefore must take heed lest the power of their apostleship be weakened by needless, useless and painful vivisections, for preaching and practice coincide, if good effect comes from the former.

The attitude toward vivisection taken by some of the best men of the age is assuredly very hostile. For example, three of the greatest poets of the century—Tennyson, Robert Browning and Whittier—have condemned it. Chief Justice Coleridge, Phillips Brooks and Morgan Dix are other illustrious men that have given severe censure. Robert Browning, a few years before his death, said:

"But this I know. I would rather submit to the worst of the deaths, so far as pain goes, than have a single dog or cat tortured under the pretense of saving me a twinge or two."

Morgan Dix, in the course of a letter written upon this subject last year, uses the following language: "I have read accounts of the tortures inflicted in the name of science on the creatures committed to our care or placed in our power by a Divine providence, and they have made me sick at heart for weeks together. I shall never peruse these frightful statistics again. I have read what arguments are made in extenuation or recommendation of the practice, and their only effect has been to strengthen my conviction that man is capable of becoming the most barbarous and most merciless of all agents."

It is wise for physicians interested in vivisection to recognize that there is on the part of prominent women and men in the laity a strong sentiment of antagonism to experiments upon animals, and therefore they should avoid all such work not promising certain benefit to man, and anæsthetics ought always to be employed. I sometimes fear that the anæsthesia is frequently nominal rather than real, else why so many and ingenious contrivances for confining the animal during operations—contrivances that are not made use of in surgical operations upon human beings, their immobility being secured by profound anæsthesia.

While it is my belief that the majority of vivisectors pursue their work out of ardent love of science, or desire to benefit humanity (and I trust they carefully and conscientiously avoid inflicting needless pain), there are others who seem, seeking useless knowledge, to be blind to the writhing agony and deaf to the cry of pain of their victims, and who have been guilty of the most damnable cruelties, without the denunciation by the public and the profession that their wickedness deserves and demands. These criminals are not confined to Germany or France, to England or Italy, but may be found in our own country.

Should the law restrict the performance of vivisection? I think it ought, chiefly as an expression of public sentiment and for moral effect. . . .

That restriction ought to forbid all experiments upon animals made without worthy objects; and in every case, so far as possible, the animal during and subsequent to the operation must be preserved from pain. Original investigations, very often a euphemism for vivisections, may seem quite fascinating to the young medical student, and possibly he thinks thereby to find a short road to fame; the result frequently remains in the embryonic condition of manuscript read chiefly, if not exclusively, by the author. But such investigations ought not to be made except under the directions of a qualified and conscientious teacher, who will see that they have a reasonable probability of usefulness, and that they are conducted so that no pain or the least possible pain is inflicted. Vivisection is in more danger from ignorant, rash, and reckless experimenters than from those directly hostile to it. I cannot think that vivisections done for teaching purposes, simply showing what has been proved time and again upon hundreds and thousands of victims, are justifiable, unless anæsthesia is employed not merely to mitigate, but completely to abolish, suffering of the animals. If the rule just mentioned is not observed, the influence of such experiments is injurious both to the operator and to the witnesses of the operation.—Extracts from the annual address before the American Academy of Medicine.

* This was written in 1891. Already, in 1895, the "anti-tuberculous inoculations" have been given up.

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